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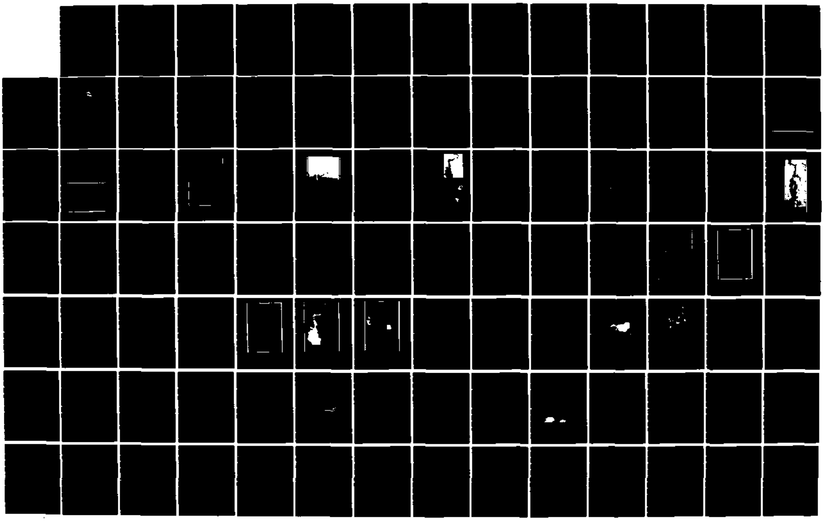

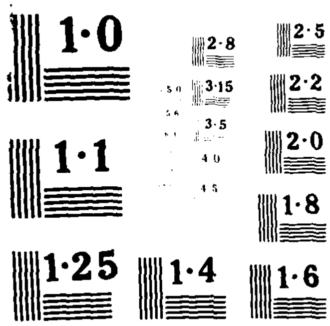

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Image-Based Approach to Mapping, Charting, and Geodesy

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Prepared for
U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060

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National Aeronautics and
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Jet Propulsion Laboratory
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Pasadena, California

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Use of the Jet Propulsion Laboratory Image-Based Information System (IBIS) is explored for mapping, charting, and geodesy. Methods and capabilities are detailed, and recommendations are made on ways to expand the system. A comparison is made of the approaches used in geographic information systems by the Jet Propulsion Laboratory and the Analytical Sciences Corporation.

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ABSTRACT

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ACRONYMS

CF	composite feature
DIME	dual independent map encoded
DMA	Defense Mapping Agency
ERA	Earth Resource Applications Group in the Image Processing Laboratory
ETL	U.S. Army Engineering Topographic Laboratories
GIS	geographic information systems
IBIS	Image-Based Information Systems
IPL	Image Processing Laboratory
JPL	Jet Propulsion Laboratory
LCGU	least common geographic unit
MC&G	mapping, charting, and geodesy
MF	IBIS mathematical function program
MSS	multispectral scanner
TASC	The Analytic Sciences Corporation
VICAR	Video Image Communication and Retrieval

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SECTION I

INTRODUCTION

1.1 BACKGROUND

The Earth Resources Applications (ERA) Group of the Image Processing Laboratory (IPL) at the Jet Propulsion Laboratory (JPL) has been involved in geographic remote sensing research since the early 1970's. During the last decade, several applications based on digital processing of remotely sensed data have been undertaken, resulting in increased knowledge of both the artificial and natural environments. As early as 1974, it became apparent that remotely sensed data, even Landsat, did not always provide sufficient information to conduct particular spatial studies. Consequently, multistage analysis techniques were employed in hope of obtaining more useful information. Data obtained from several sources as well as temporal "scenes" were often combined for analysis.

With continued advancement and development of remote sensing technology, two major problems were encountered. First, the availabiliy and abundance of remotely sensed data for geographic analysis was staggering. Methodologies had to be developed to reduce the volume of data into manageable collections while still proving to be useful to the subsequent users of the data. Second and more important, for remotely sensed data to be most useful, they must be analyzed in conjunction with other forms of data frequently used in geographic analysis such as planimetric and thematic maps, or demographic information. The solution to both of these problems was to be found with the development of geographic information systems (GIS). Geographic information systems could enable the merging of remotely sensed and more traditional geographic source materials for spatial analysis and modeling. Furthermore, GIS could be used for reduction and storage of remotely sensed data, becoming an efficient archival system.

After investigating [illegible] (Bryant, et al., 1976), ODYSSEY, and a number of other vector-based topologically structured GIS, geographers and computer scientists at JPL realized that these GIS were not designed with the capability to process remotely sensed data efficiently and effectively. It was from this requirement that the Image Based Information System (IBIS) was developed in 1975 (Bryant and Zobrist, 1977). Today, IBIS is a very extensive raster-based GIS, containing nearly 75 programs for the manipulation of spatial data. IBIS has been implemented at several NASA Centers (Ames Research Center, Goddard Space Flight Center, Johnson Space Center), at many state agencies in the western United States (California, Nevada, Arizona, Idaho, Montana, and Washington), and at several university research centers ([illegible]).

1.2 IBIS: A UNIQUE [illegible]

When compared to other GIS, IBIS is a unique system. Basically, the major difference between IBIS and other GIS is the primary mode of data

storage. While most GIS store data as strings of topologically linked vectors, the primary format for data storage within IBIS is the raster or digital image.

There are several advantages to storing data in raster format, one of which is that coordinates are not required to designate the location of features, their location being derived implicitly by their position in the raster. But most important, since one primary objective of the GIS is to combine remotely sensed and more traditional forms of spatial data, a raster-based storage system provides the most efficient means to establish the desired link. It is very easy to depict information obtained from thematic and planimetric maps in image format. However, it is not easy to depict image data in vector-space.

Another feature which sets IBIS apart from all GIS, is that IBIS is [illegible] an extensive image processing system commonly referred to as VICAR ([illegible] Image Communication and Retrieval). The development of VICAR began in [illegible]-1960's, "to facilitate the acquisition, processing, and recording of [illegible] image data" (Seidman and Smith, *1979, 1-1*). *Initially VICAR was a* [illegible] the planetary scientist, and was used to map the Moon, Mars, Mercury, [illegible] of Venus. Most recently, VICAR has been used to process data [illegible] from the two Voyager spacecraft.

VICAR is an extremely flexible and versatile system, and in [illegible] to planetary image processing, it has been used for processing [illegible] of the Earth, man-made objects, and the human body. With respect to [illegible] of Earth resources, *applications using VICAR and IBIS have been* [illegible] since the mid-1970's.

[illegible] Cartographic Applications with IBIS

[illegible] earliest applications of IBIS were designed to effectively [illegible] information obtained from digital processing of Landsat [illegible] that more useful to the urban planner. *This was accomplished by* [illegible] data with some form of geo-reference material for the [illegible] land cover distributions within commonly known boundaries [illegible] tracts, (Zobrist and Bryant, 1976; Bryant, 1976). IBIS proved [illegible] tool for these purposes.

[illegible] expansion and improvement in the system, IBIS was used [illegible] materials for use during the primary stages of [illegible] (Bradler, et al., 1978). Data types which [illegible] digital Landsat data for multispectral [illegible] available to the analyst.

[illegible] operations [illegible] data, [illegible] digital mosaics (Clark, [illegible] have been completed.

Some of these mosaics are in fact multi-layered data bases containing Landsat imagery and digital terrain information, in addition to land cover data obtained from multispectral classification. Highly sophisticated image registration (geometric transformations) routines enabled the structuring of these data bases with precise planimetric qualities (Zobrist, 1979). When multispectral data was not available for all aspects of a spatial analysis problem, IBIS provided the technology for merging Landsat with non-image data in modeling applications.

Urban expansion around major metropolitan areas was modeled through the combination of Landsat and census data depicted in an image format (Friedman, 1980). Land cover maps and tabular reports emphasizing census tracts which exhibited marked transitions from non-urban to urban land were denoted.

Cartographic applications, solely based on the analysis of thematic maps and other non-image source materials, have also been completed with IBIS. In one application, the potential for extraction of coal from a particular seam in Illinois was determined (Farrell and Wherry, 1978). That project required the building of a complex data base consisting of several digital images that were constructed from a variety of source material obtained in various scales, formats, and levels of completeness. A more recent application (Logan, 1981) dealt with the analysis and modeling of the potential for debris slides occurring within mountainous terrain.

1.2 PURPOSE OF RESEARCH

Researchers at the U.S. Army Engineer Topographic Laboratories (ETL) have been interested in determining the capabilities and drawbacks of various GIS for mapping, charting and geodesy (MC&G) applications. After learning the capabilities of the ODYSSEY System (a vector-based topologically structured GIS) for MC&G applications (Sharpley, et al., 1978), the ETL researchers became interested in determining if a raster-based GIS could be more useful for MC&G programs.

In a cooperative effort between JPL and ETL, a program to test MC&G capabilities of IBIS was formulated and implemented. The primary center for this research was the Image Processing Laboratory at JPL, while technical direction remained with the ETL. The purpose of this report is to provide researchers at ETL with the results of MC&G research conducted at JPL under contract NAS7-100, Task Order RD-182, Amendment No. 125, entitled An Image Based Approach to Mapping, Charting, and Geodesy (1980). The period of research was from January to August 1981.

1.2.1 Research Objectives

The purpose of the MC&G task was to demonstrate the utility of a raster-based approach to mapping, charting, and geodesy. The following objectives were emphasized during the execution of the MC&G task:

(1) Demonstration of basic data manipulation capabilities of IBIS including vector-to-image conversion, geometric and planimetric rectification, and polygon overlay.

(2) Demonstration of the capability to incorporate digital imagery (e.g., Landsat multispectral) and digital terrain data into the data base.

(3) Demonstration of the ability to add new data planes or update previously compiled data planes, without redigitization of basic data.

(4) Demonstration of the capability to integrate and merge data from several data planes.

(5) Demonstration of the capability to query the IBIS MC&G data base for determining answers to specific questions pertaining to information stored in the data base. Output products were to include both (1) thematic maps depicting the spatial distribution of the desired features and (2) tabular reports summarizing aerial coverage of such features.

[illegible] Implementation

The data base was constructed using an IBM 370-158 computer located [illegible] the Image Processing Laboratory at JPL. The primary software packages [illegible] in processing the data were IBIS and VICAR[1]. The source materials [illegible] provided by the ETL in the form of three film transparencies. Four [illegible] themes were included: (1) land use (Figure 1-1), (2) topographic [illegible] (Figure 1-2), (3) 100-year floodplain (Figure 1-3), and (4) land use [illegible] (Figure 1-3). These data were converted into vector format by [illegible] Corporation, a local data processing vendor. The process [illegible] the recording of all pertinent boundary features and respective [illegible] features on all three maps. The vector files were [illegible] format at JPL and eventually became the foundation for [illegible].

[illegible]

[illegible] was designed to be a comparative study to a [illegible] performed by The Analytic Sciences Corporation [illegible], et al., 197[illegible]) for the ETL. Thematic map products and [illegible] delivered by TASC to the ETL were used to provide guidelines [illegible] deliverables sent to ETL from JPL. However,

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[1] [illegible] subset of VICAR, it is frequently referred to [illegible]. The name VICAR [illegible] frequently been used in the literature [illegible] the system used for implementation of [illegible] and other spatial analysis applications.

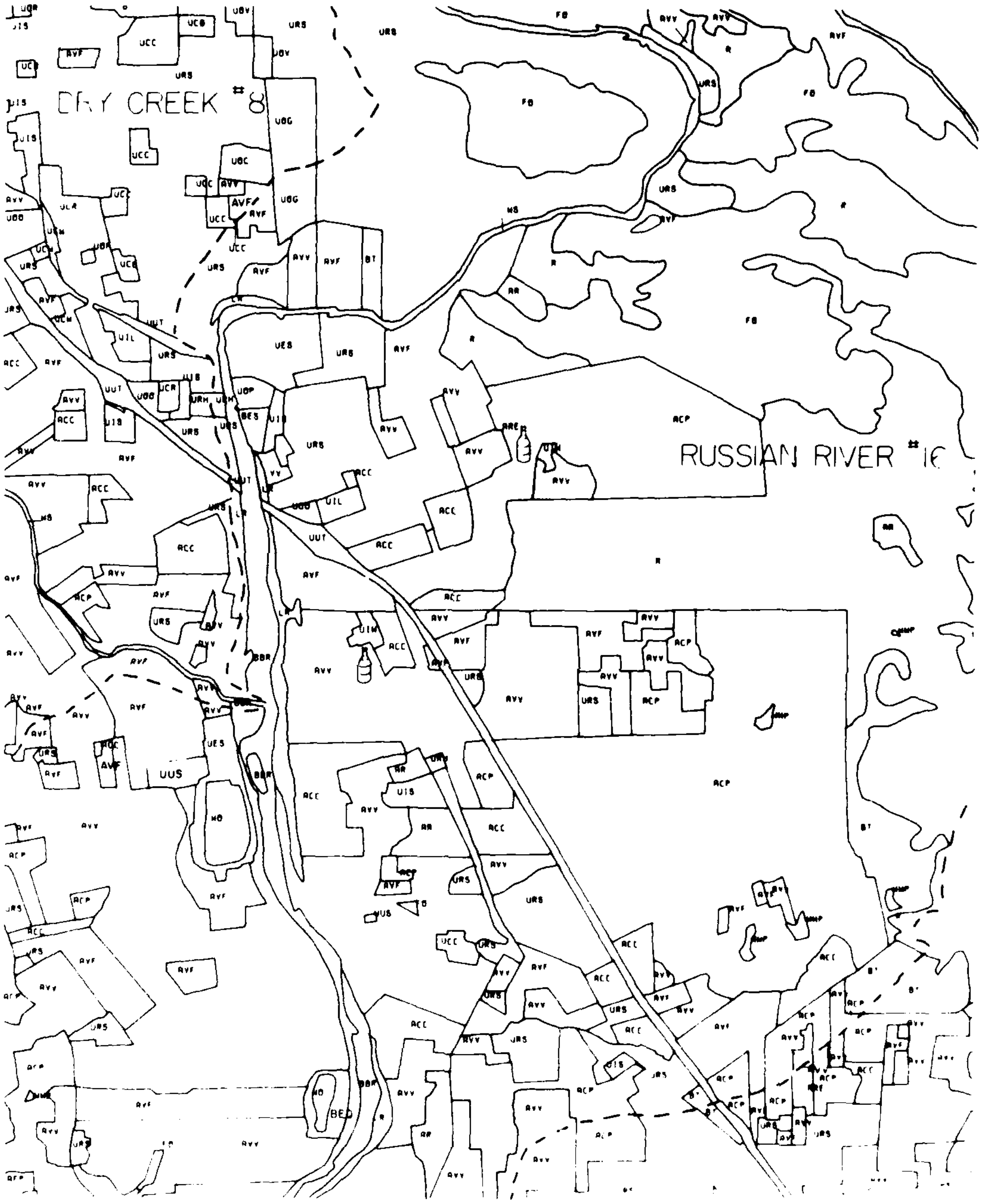


Figure 1-1. Land Use Base Map Used in the MC&G Application

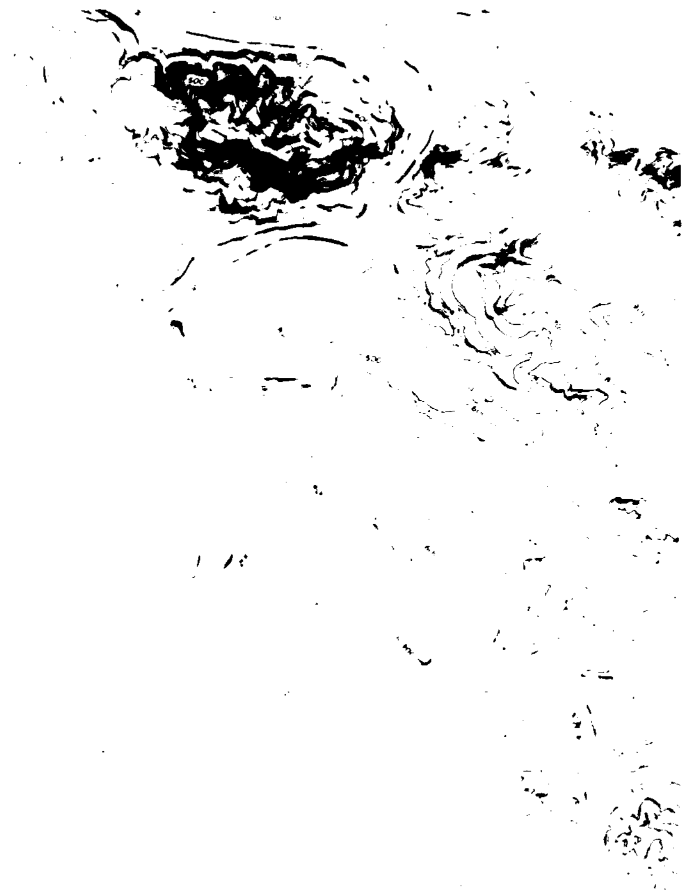


Figure 1-2. Topographic Base Map Used in the MC&G Application

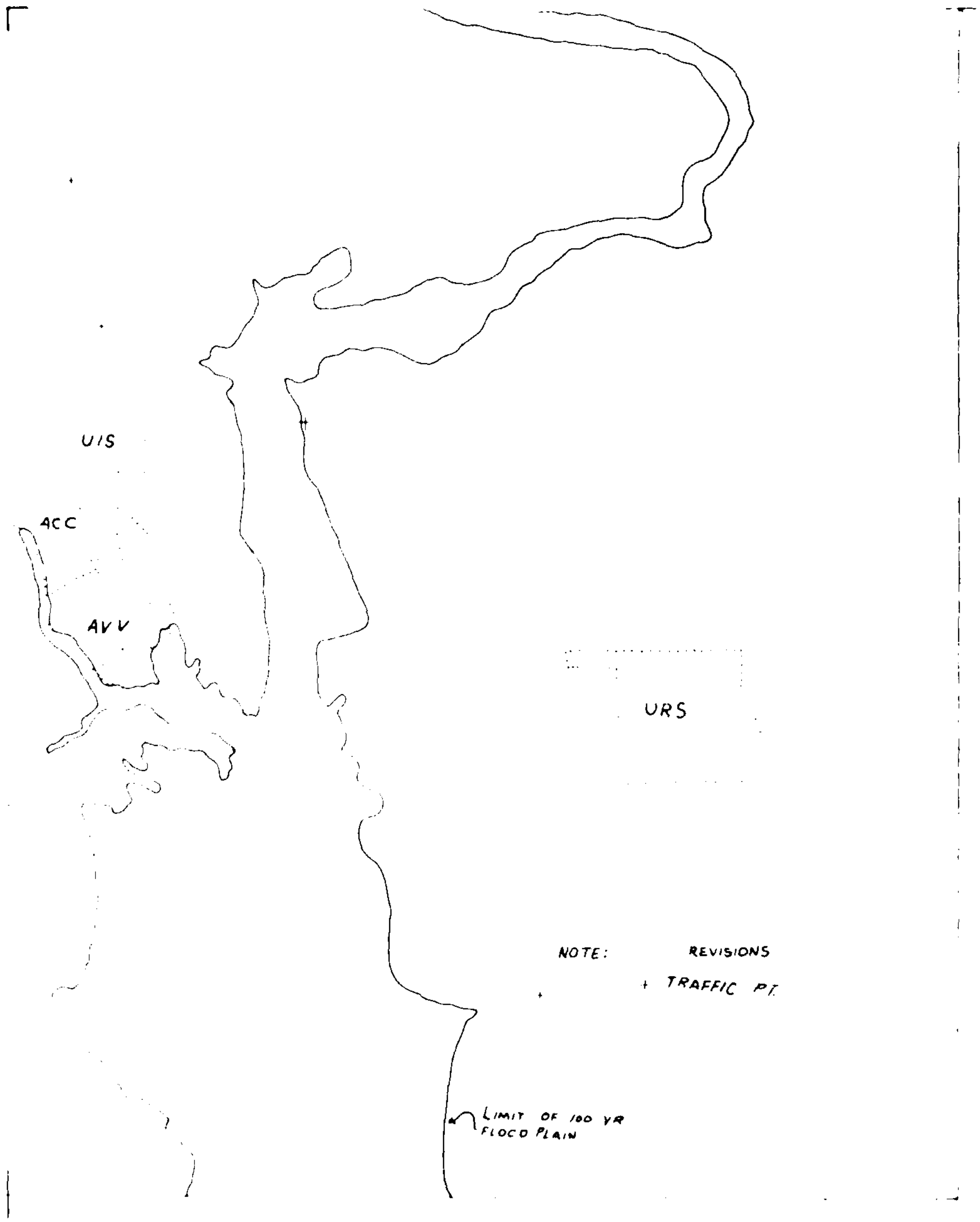


Figure 1-3. Two Themes, the 100 year Floodplain and Land Use Revisions, Provided on the Same Base Map for MC&G

where most map products were produced by printer-plotter in the TASC publication, map products were produced via digital-to-analog photo-recorders in the JPL task. Since certain inherent differences exist between raster and topological approaches to data storage, processing, and display, some products produced by JPL were not identical to those products produced by TASC.

The task was to be divided into two parts. First, a high resolution MC&G data base was to be constructed. That data base was queried to demonstrate the information retrieval capability of IBIS. A second MC&G subtask was to entail registration of digital imagery (both Landsat multispectral scanner (MSS) and Defense Mapping Agency (DMA) terrain data) to the MC&G data base. However, no imagery of the study area was available at JPL at a scale suitable for inclusion in the data base. Consequently, that subtask was not completed.

SECTION 2

CONSTRUCTION OF THE MC&G DATA BASE

2.1 PREPROCESSING

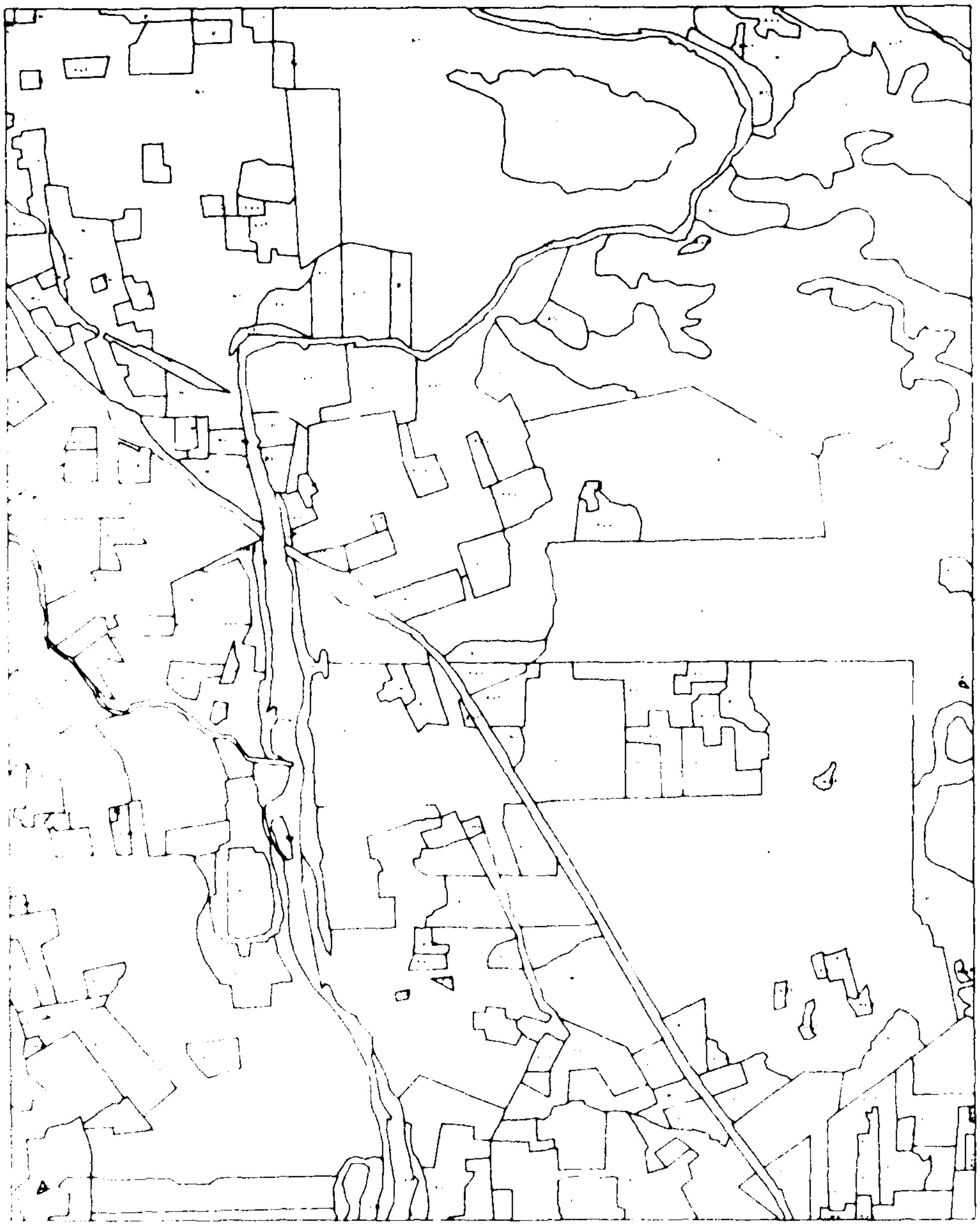
The creation of a demonstration data base for the MC&G task involved the execution of a set of data processing steps collectively referred to as preprocessing. In this context, preprocessing refers to all procedures invoked during the data base preparation and formation phase of the project. When raw data are made available in the form of map transparencies as in the MC&G application, preprocessing involves six distinct steps: (1) coordinate digitization, (2) logging and reformatting, (3) spatial rectification, (4) vector-to-image conversion, (5) raster-image region formation and identification, and (6) region labeling. When source materials are obtained in image format, preprocessing involves the steps (1) logging and reformatting, and (2) spatial alignment and rectification.

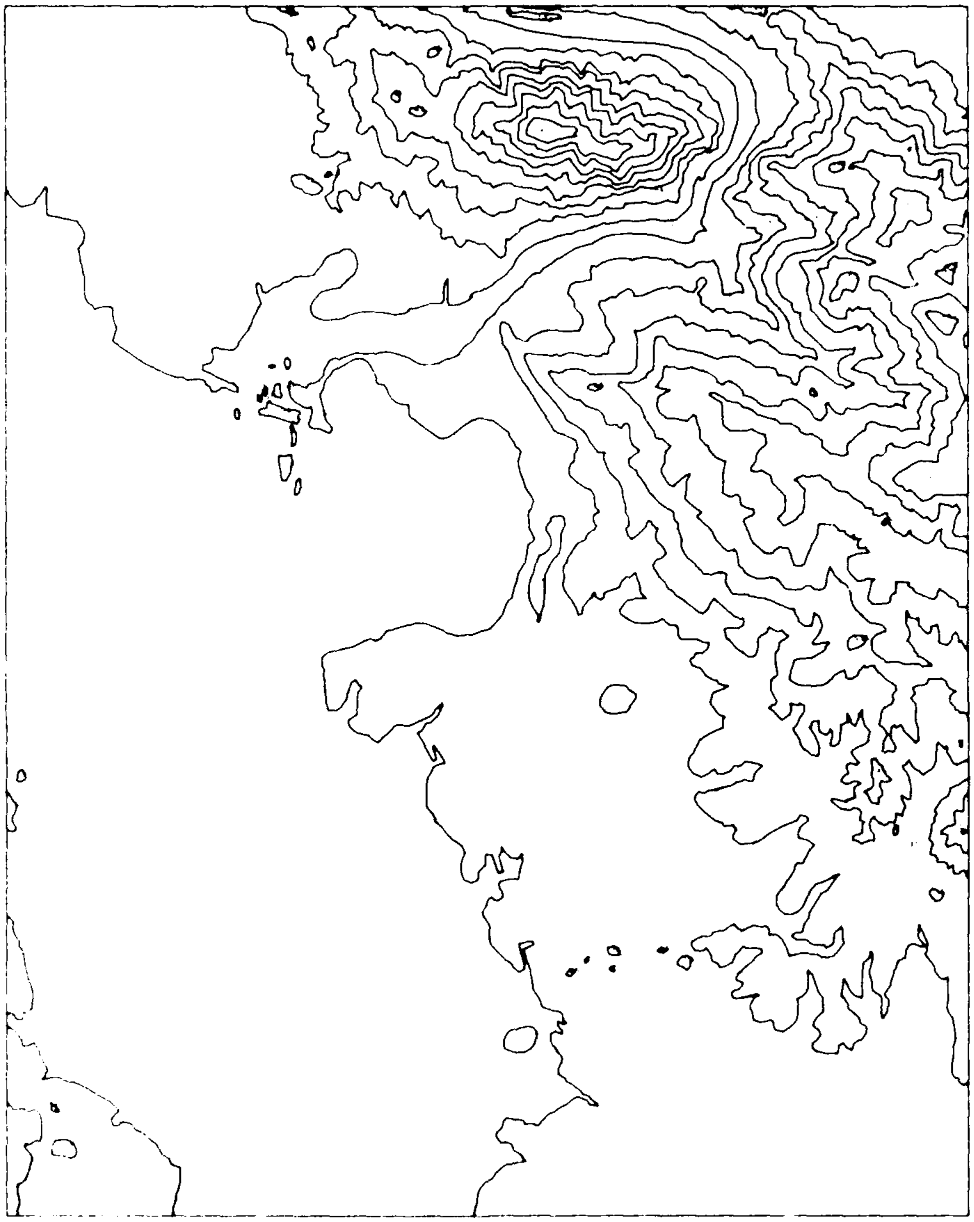
2.1.1 Coordinate Digitization

IBIS data sets which store spatial data as raster-type images are referred to as <u>data planes</u>. When source data are provided in the form of thematic maps or other two-dimentional hard copy products, the pertinent data must be converted to image format. First, line segments and other important spatial features are digitized with an electronic coordinate digitizer. The digitizer produces vector strings, or *line segments, which are then converted* to image format.

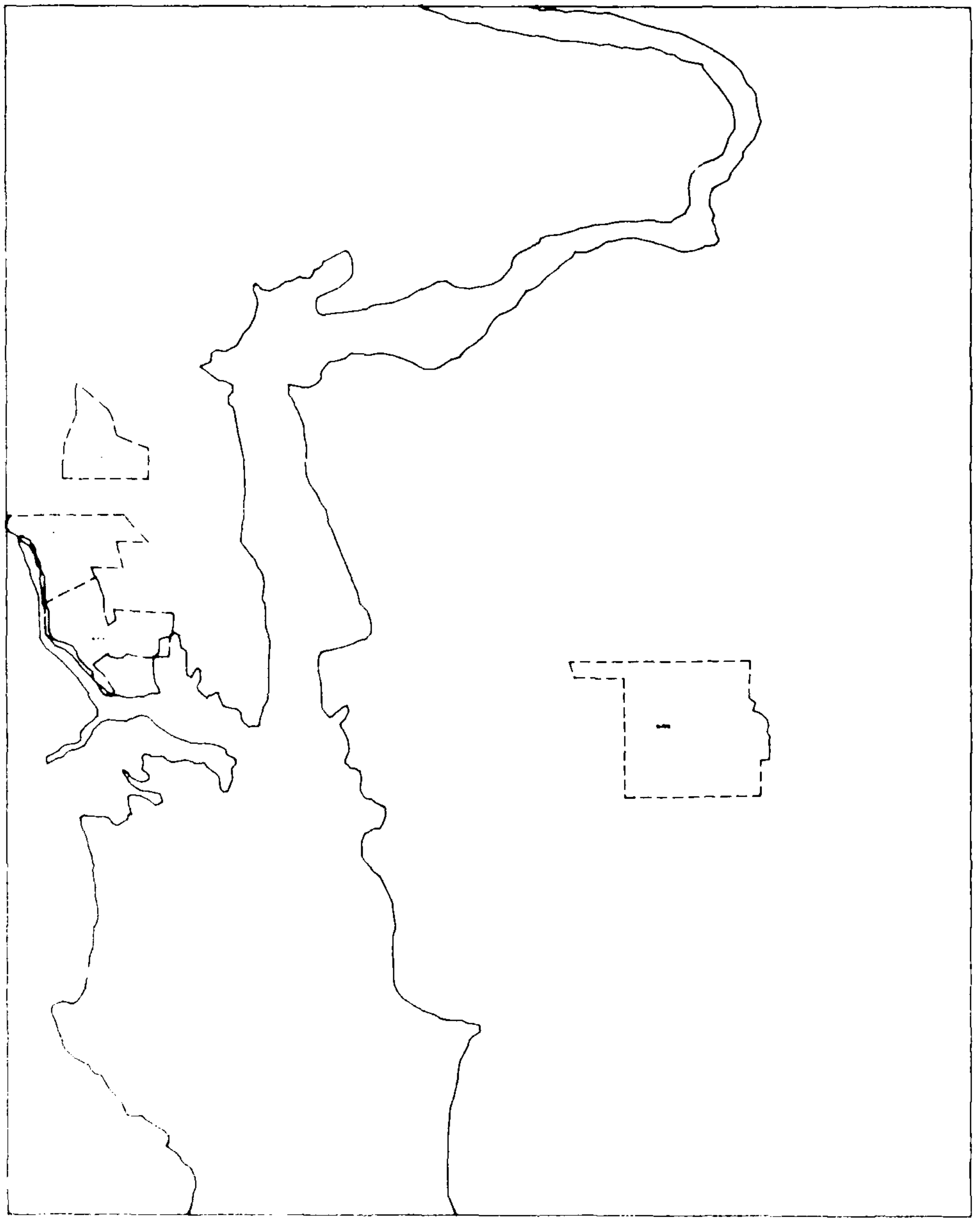
The digitizing process involves tracing all line segments bounding geographic areas (e.g., land use polygons, and census tracts) and/or recording specific points of interest (e.g., bench marks or labeled identifiers) with the aid of cursor and a specially constructed table containing a gridded network of sensors. The position of the cursor is monitored at all times by a microprocessor; and as line segments are traced by the digitizer operator, they are recorded on magnetic tape or other peripheral storage device. With the more sophisticated systems, on-line editing of the data can be performed [illegible].

For the MC&G application, coordinate digitization was performed by [illegible] Corporation, a local vendor. They produced two separate [illegible] for each of the four thematic overlays. First, line segments defining [illegible] features were digitized from each overlay. Then, another set of [illegible] produced containing centroid information. Check plots (Figures 2-1 [illegible]) were prepared by the vendor to verify the quality of the [illegible]. [illegible] land use overlay (See Figure 2-1) was actually digitized in [illegible] to demonstrate the capability of IBIS to merge [illegible] maps.





[illegible] Produced by the Vendor



[illegible] [illegible] and Reformatting

[illegible] digitized map data were transferred from the vendor to JPL as separate files on magnetic tape. As the first step in forming the IBIS data base, these files were modified to conform to VICAR system standards. The process involved the addition of proper label information to each file. The labels describe features and specifications for the VICAR system. Additionally, the data were reformatted to conform to IBIS vector file specifications. This processing step, characterized by a preparatory stage, is referred to as [illegible].

[illegible] Spatial Rectification

When building a geographic data base, spatial continuity between all [illegible] of the data base must be maintained. To ensure this situation, all data [illegible] are registered to a planimetric base known to have good spatial [illegible]. For vector data used in the MC&G operation, two types of spatial [illegible], affine and geometric, were utilized to ensure spatial integrity [illegible] the data base.

All source materials used in building the MC&G data base were [illegible] from a USGS, 1:24000, 7-1/2 minute topographic map and from [illegible] with that topographic map. Since the polyconic projection [illegible] of spatial continuity for small geographic regions, the [illegible] selected to be the planimetric base for the data base. All [illegible] data files were transformed to the image space of the [illegible] simple two-dimensional affine transformation[2] [illegible] (Figure 2-4). The procedure in itself was [illegible] land use sections, the contour map, and the 100-year [illegible].

[illegible], after the affine transformation was applied to the land use [illegible] to the planimetric base was not [illegible] geometric rubber-sheeting operation [illegible] to eradicate local registration [illegible] (Figure 2-6) was established

---

[illegible], and lower left) were selected to [illegible] coordinates of the digitized data [illegible], and [illegible] space (line, sample) were [illegible] for a scale reduction [illegible] error was made [illegible] affected the relative scale along [illegible] source of the [illegible] to (1., 1.), (1., 9[illegible].), [illegible] scale error. Consequently, a [illegible] obtained. The relative scale of the [illegible].

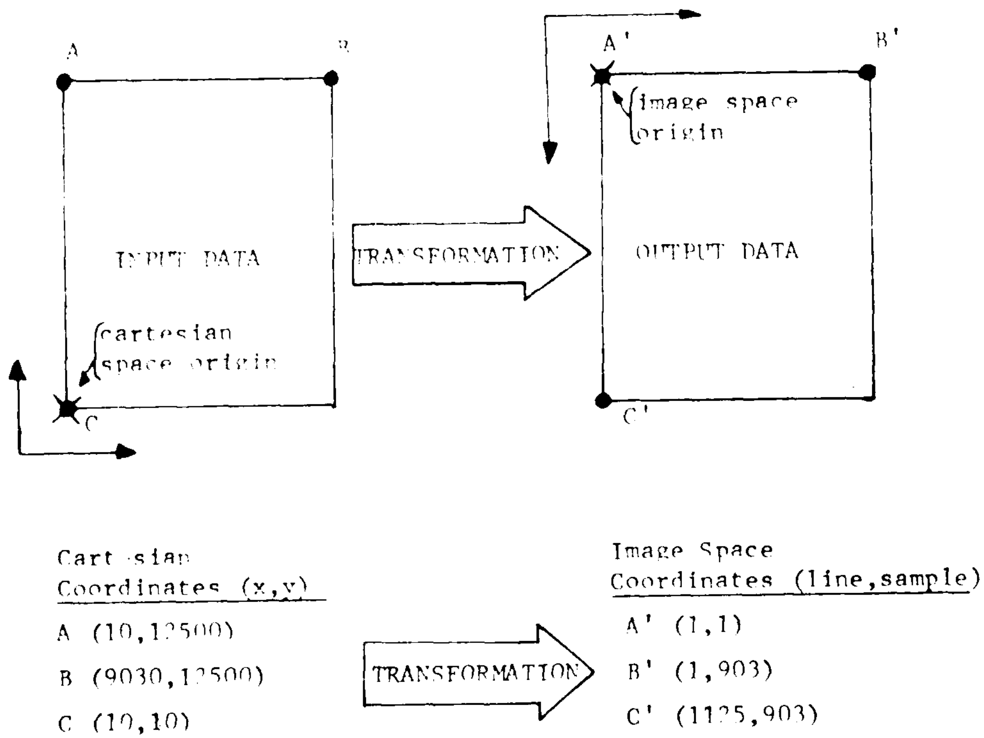


Figure 2-4. Location of Three Tiepoints Used for Affine Transformation of the Digitized Thematic Map Data from Cartesian to Image Space

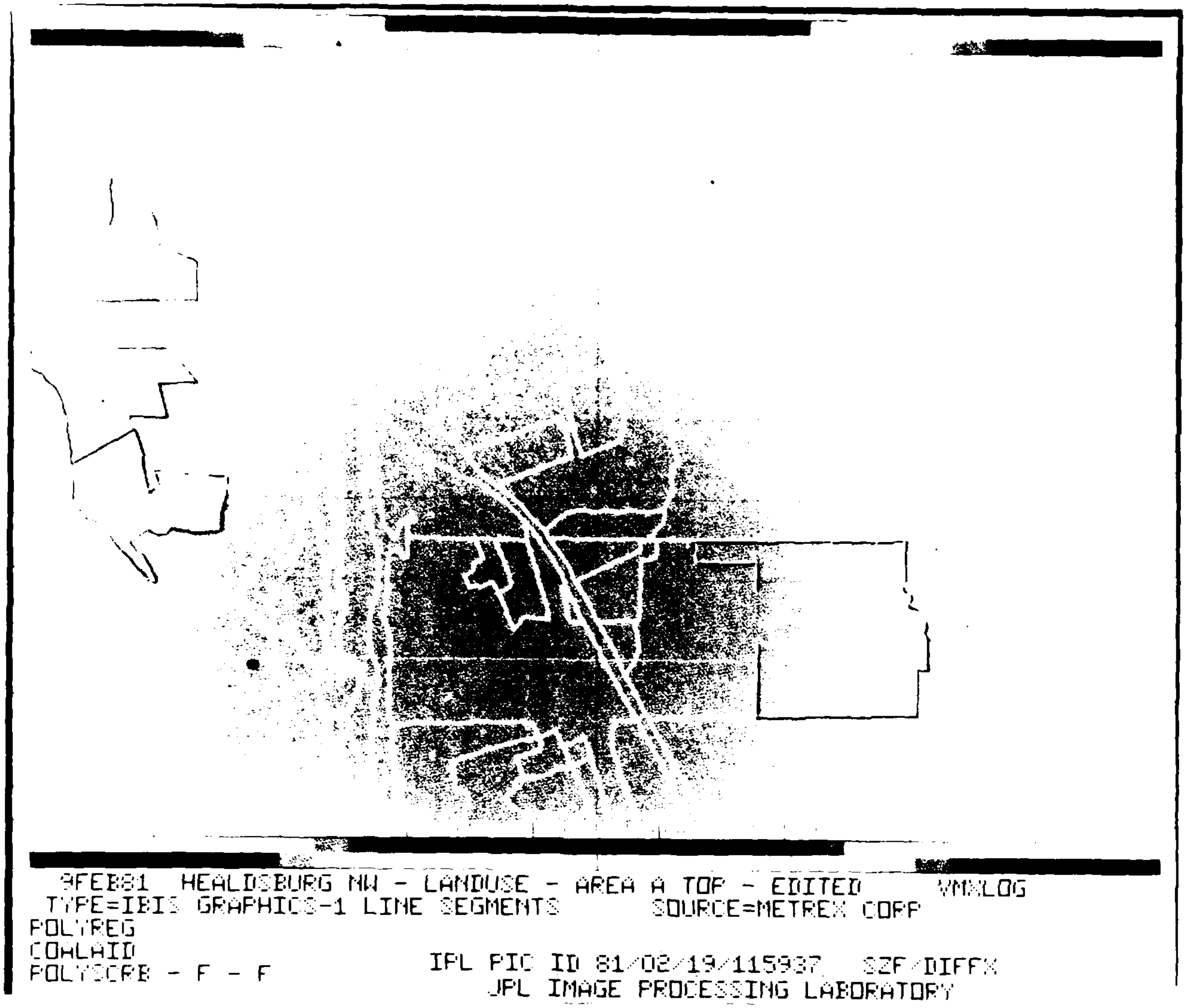


Figure 2-5. *Overlay Showing Pixel Misregistration Caused by* Affine Transformation (The affine transformation of the land use revision overlay to the georeference base resulted in an average misregistration of three pixels as seen in the overlay of the land use and land use revision data planes.)

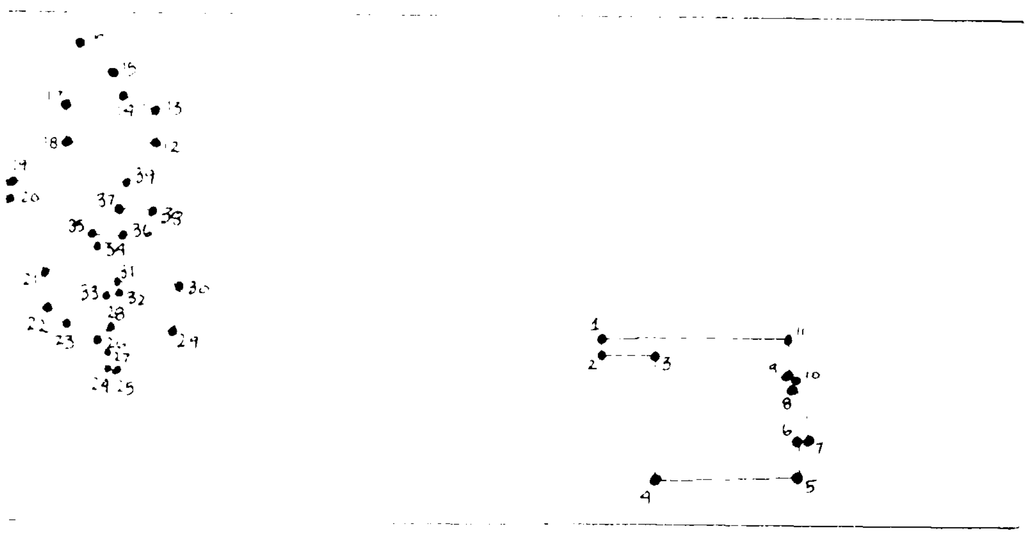


Figure [illegible]. Location of 39 Tiepoints Used in Geometric Rubber Sheet Transformation of the Land Use Revision File to the Reference Base

to control the transformation. Distortion removal by rubber sheeting has been found to be effective for rectifying spatial anomalies frequently attributed to differing map projections and map compilation practices. After geometric transformation, the correspondence between all data sets was acceptable (Figure 2-7).

2.1.4 Vector-to-Image Conversion

The affine and geometric transformations were performed on the line segment data while they were in vector format. Upon satisfactory completion of the spatial tranformations and selective editing[3] of line segment information, the vector data were converted into digital images[4]. Four individual images, or data planes, were produced: (1) land use, (2) 100-foot (30.4-m) elevation contours, (3) 100-year flood plain, and (4) land use revisions (Figure 2-8).

The land use map was digitized in two sections (Figure 2-9); they needed to be combined to form the complete land use data plane (Figure 2-10). No apparent seams, extra lines, or artifacts resulted from the juxtaposition of the two images.

After the four thematic image planes were produced, a special composite image was created by combining the segments of the four source images. That image, referred to as a composite-feature (CF) data-plane (Figure 2-11), was established to enable effective querying of the data base in later operations. The CF base is similar in concept to the least common geographic unit approach (LCGU) used in ODYSSEY (Sharpley, 1978,pp. 3-4) and other vector-based mapping systems.

2.1.5 Region Formation and Identification

After conversion from vector to image format, the IBIS raster-region formation and identification process was performed on all four thematic data planes in addition to the CF data plane. Being very different from the complex procedures utilized in vector-based systems which include locating and identifying of nodes, arc-segments, and minimum mapping units, the IBIS process utilizes a simple painting procedure that assigns each separate geographic region with a unique nominal identification code.

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[3] Some line segments were not properly digitized by the vendor. To ensure that the data base would be properly structured, all files were edited at JPL to ensure that any missing line segments were added before building the data base.

[4] Integer units are directly converted to image space pixel locations. Each of the image planes measured 900 x 1120 pixel units and were comprised of [illegible] pixels. The line segments were encoded as white (255 DN) while the background areas were encoded black (0 DN).

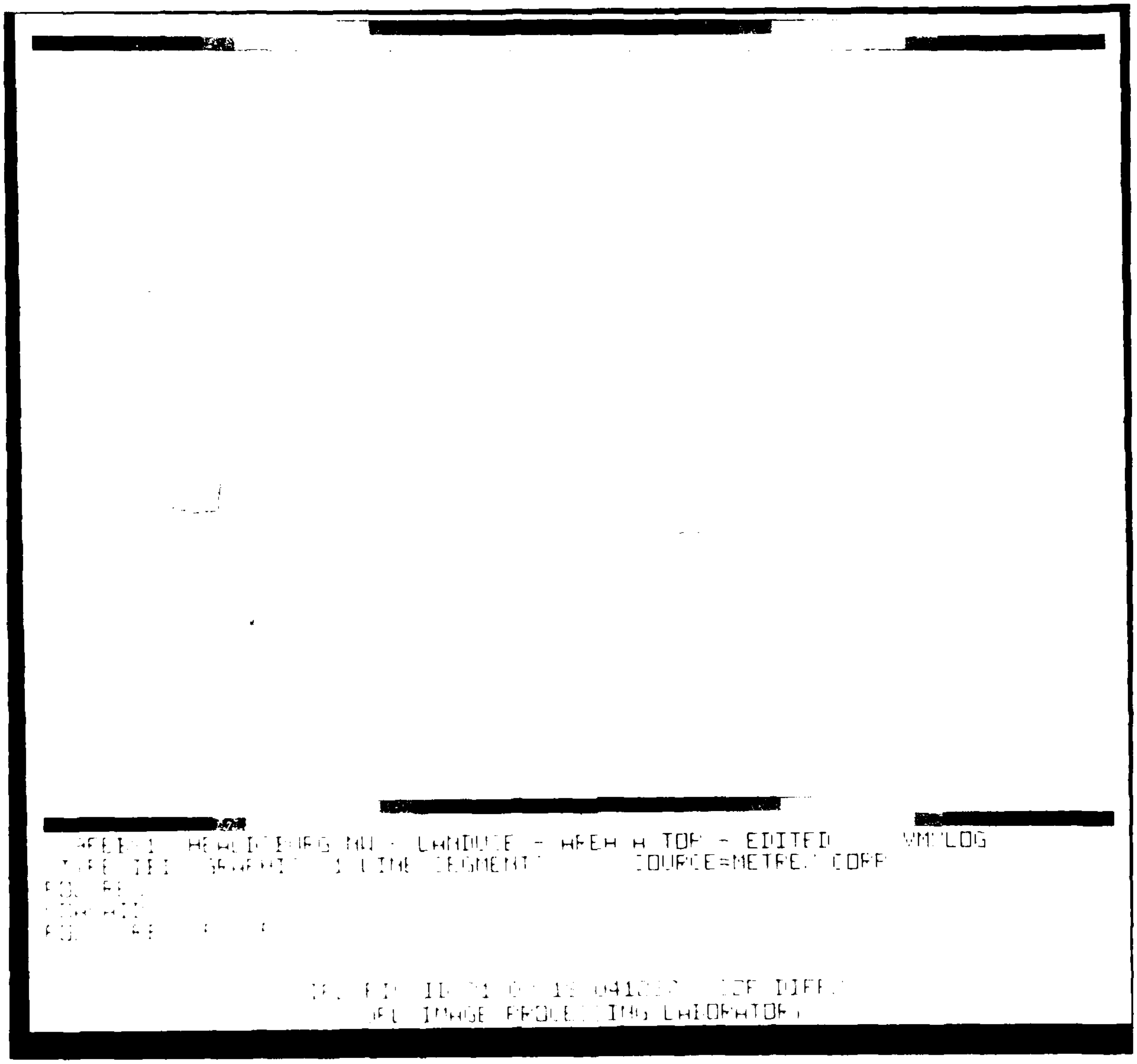


Figure [illegible]. [illegible] Produced by [illegible] Rubber-Sheet Transformation ([illegible] rubber-sheet transformation of the land use [illegible] the [illegible] base proved to be effective.)

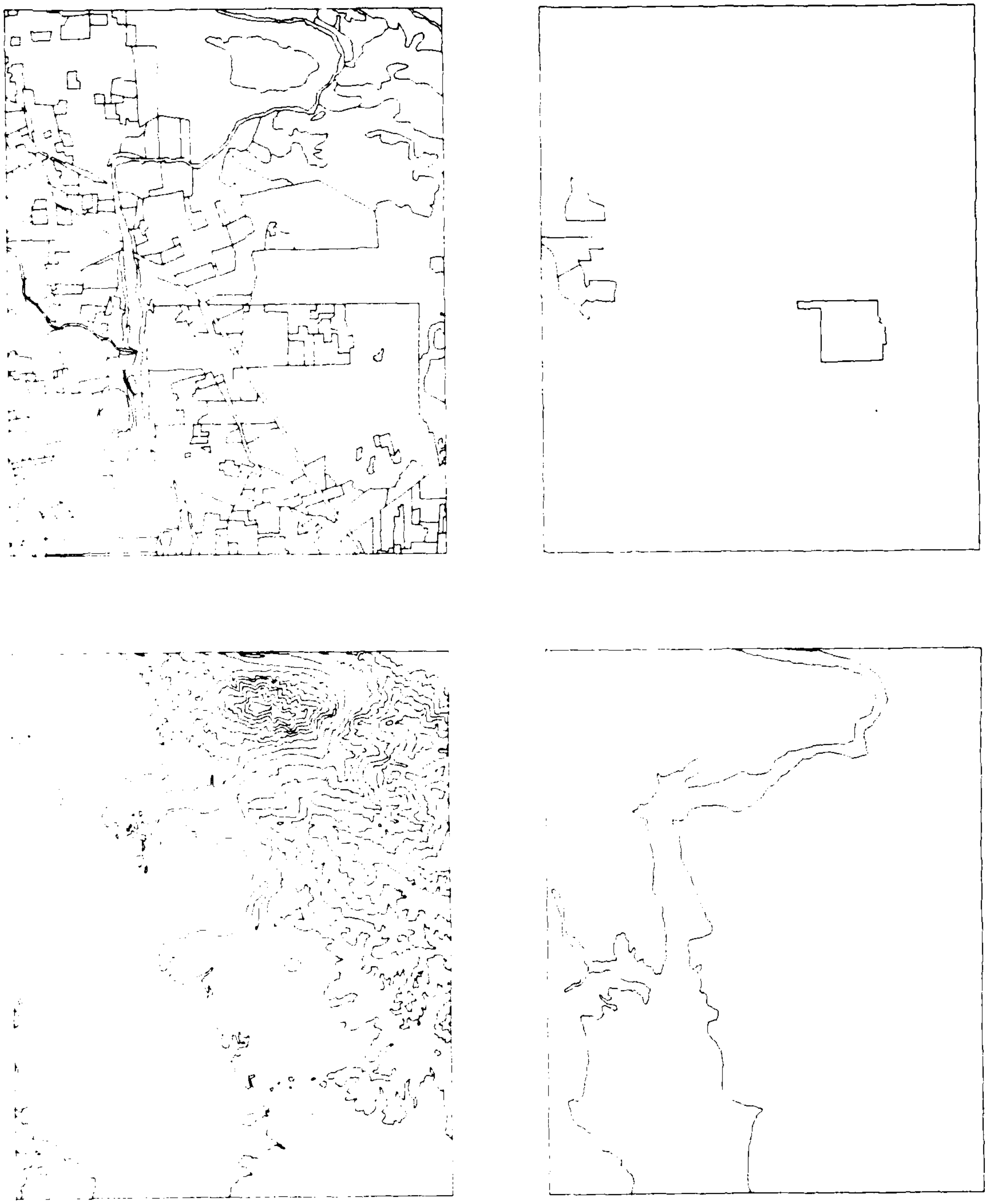


Figure 2-8. Images showing the Four Data Planes (The four data planes: land use, 100 foot contours, 100 year floodplain, and land use revisions were converted into image format and became the foundation for the MC&G data base.)

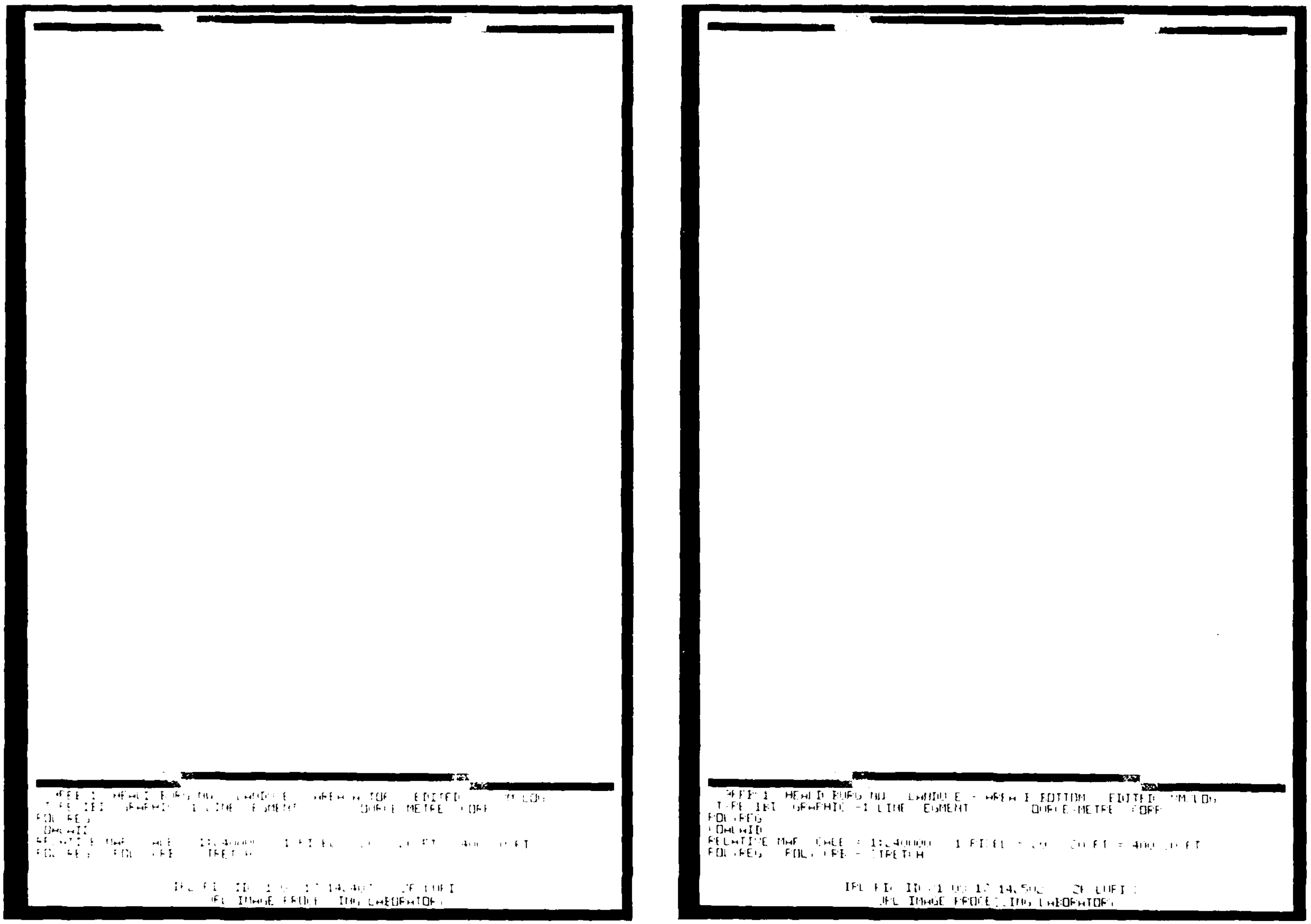


Figure 2-9. Land Use Overlay Digitized in Two Sections (This was done to demonstrate the ability to merge data from two adjacent map sheets.)

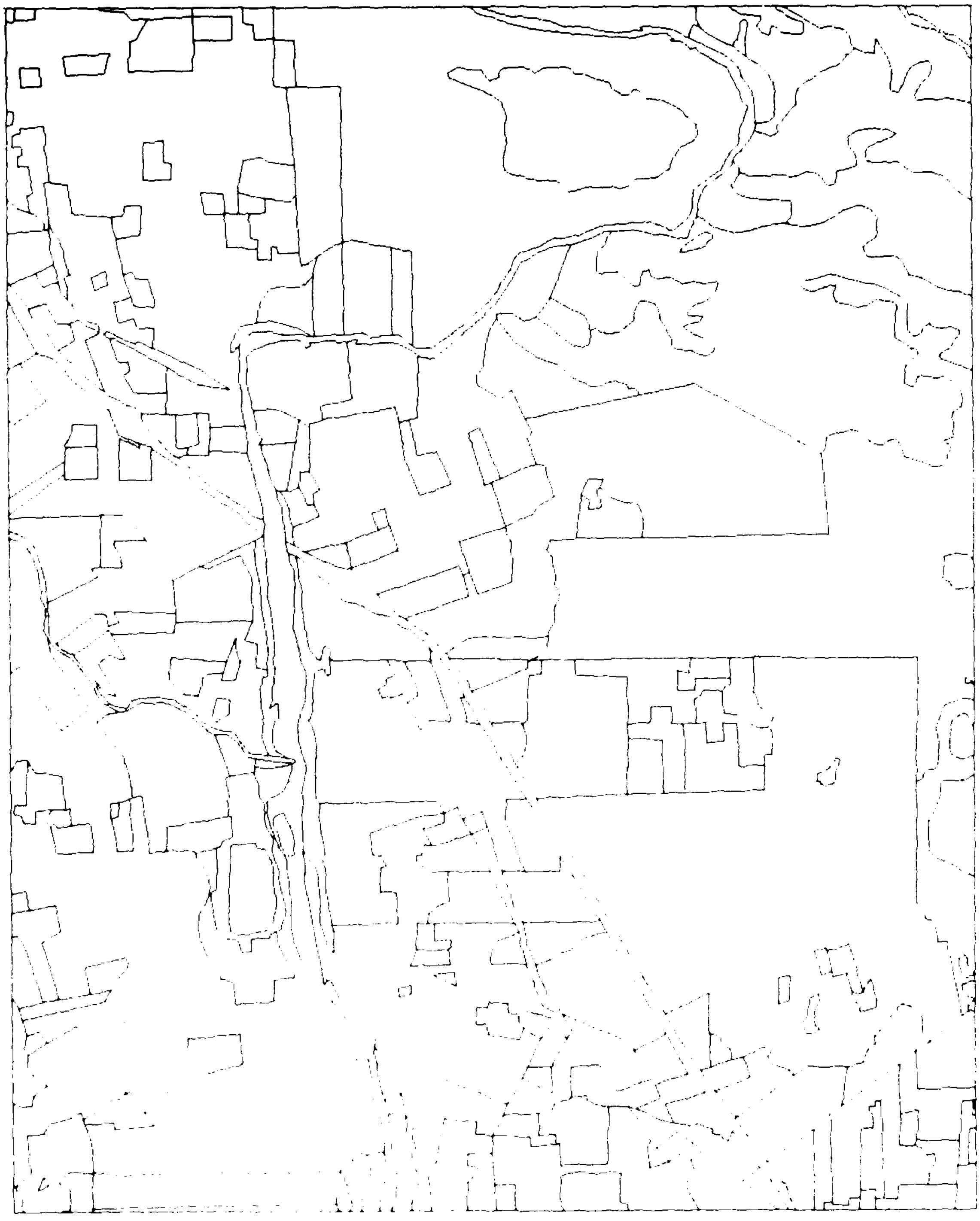


Figure [illegible]. Land Use Data Plane after Concatenation of the Two Parts, Top and Bottom

[illegible]
[illegible]
[illegible]

[illegible]
[illegible]

[illegible]

With IBIS as in other GIS, geographic regions are bounded on all [illegible] line segments and/or the edge of the mapped area, and minimum mapping [illegible] are found. However, instead of processing polygons as a set of related [illegible] and line segments as vector systems do, the IBIS approach deals specifically with the identification of areal features as bounded by line segments. Rather than assigning attributes directly to line segments, the IBIS painting [illegible] the same nominal identification code to all pixels within a [illegible] geographic region. Thus, an IBIS region file is a raster image where [illegible] can be identified as being part of a specific region instead of another [illegible] of the pixel encoding scheme.

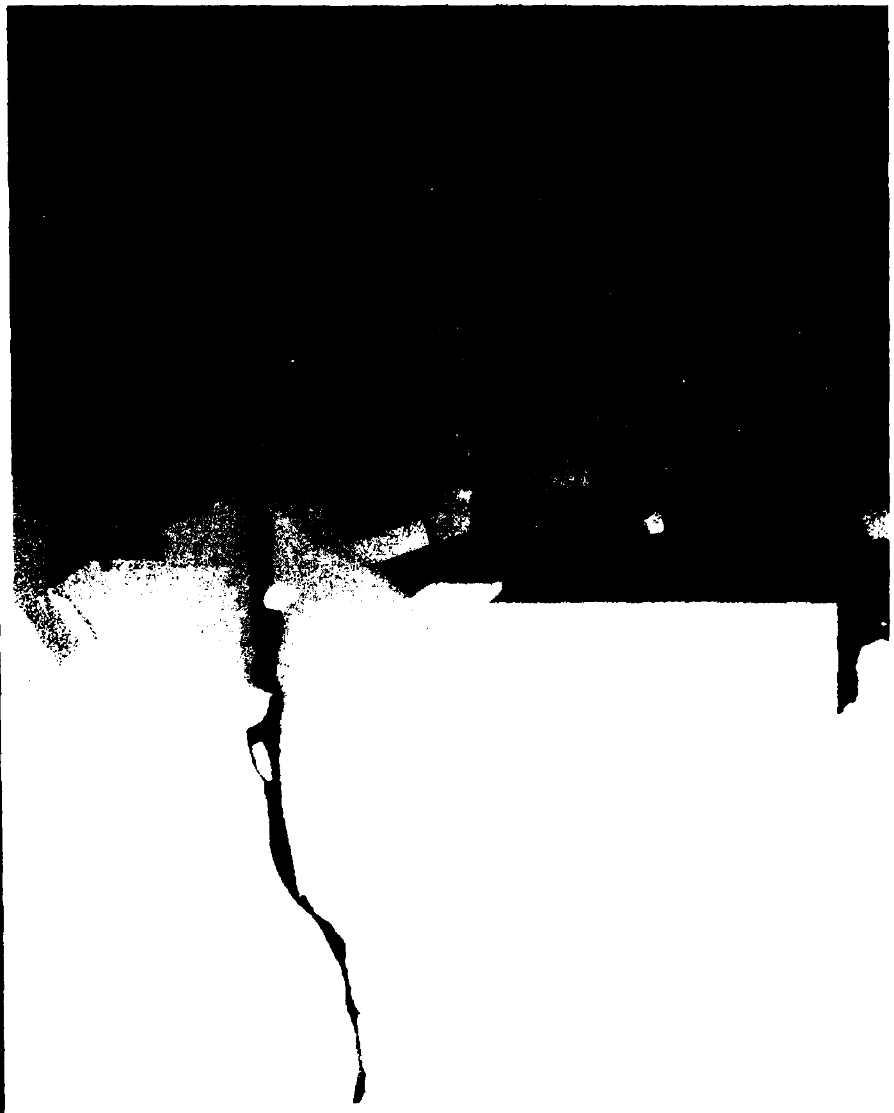
[illegible] the [illegible] application, the number of unique geographic regions [illegible] were determined (Table 2-1). The actual number of regions [illegible] IBIS data base slightly exceeded manual tabulation of geographic [illegible] the source maps in almost every case. The difference in count was [illegible] to be caused by a combination of two factors: digitizing error and [illegible] representation. When the vendor (Metrix) digitized the map material, [illegible] that the digitizer operator inadvertently traced adjacent line [illegible] error, causing the segments to converge. If the line [illegible] of the same polygon, the convergent lines would cause [illegible] two independent polygons. Thus the original polygon would be [illegible] polygons. The formation of the data base at a scale factor [illegible] data collection scale causes the same effect when the [illegible] line segments are slight. Increasing the resolution [illegible] can alleviate this problem if too many pinchings [illegible].

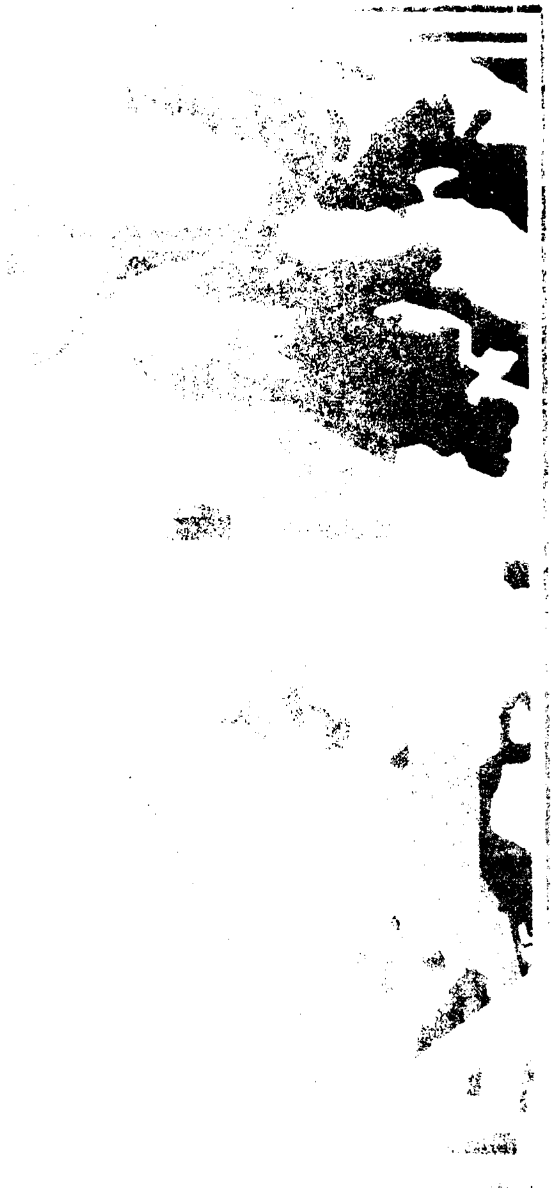
[illegible] of each nominally encoded geographic region [illegible] (Figure 2-1[illegible]). Consequently, a four-color mapping [illegible] to enable visualization of the regional morphology [illegible]. [illegible] technique was utilized to enhance the visual quality [illegible] (Figure 2-1[illegible]). This technique is primarily used [illegible] operation. Its main function is in determining that all [illegible] been properly identified. At times, digitizing error may

Table 2-1. [illegible] for the individual data bases

[illegible]	Content	Number of Polygons
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	
	[illegible]	[illegible]

[illegible] PAINT [illegible]








[illegible] breaks in line segments. When such a situation occurs, two adjacent regions will be encoded with the same nominal code. The four-color mapping algorithm can be useful at times to spot these errors.

[illegible] Region Attribute Assignment

Although all individual geographic regions comprising each thematic [illegible] were identified and labeled through the use of the painting procedure, the [illegible] images alone do not comprise the total geographic data base for the [illegible] project. Having no name or logical identity in the real world, these [illegible] images cannot be used effectively. A link had to be established between these images and the real world. Attribute names and/or labels [illegible] the original base maps would provide the needed link.

As described in the previous section, two types of information were [illegible] from the thematic map sheets: (1) line segments, and (2) centroids. The centroid data, containing points in cartesian space and associated map [illegible], provide the needed link.

The centroid data were processed with the same set of procedures [illegible] the line segment vector files through the steps: (1) coordinate [illegible], (2) [illegible] and reformatting, and (3) spatial rectification. [illegible], centroid data were never converted to images. Instead, the data were [illegible] an [illegible] interface file. Each interface file [illegible] information: (1) the numerical codes assigned to each [illegible], and (2) the associated polygon label as [illegible]. [illegible] the link between the polygon file and reality [illegible] file. The land use revision [illegible] interface file, can be used to [illegible] interface file upon completion of the procedure [illegible].

[illegible] Interface File for Land Use Revisions

[illegible]	POLYGON LABEL
	[illegible] (non-change areas)
	[illegible]
	AGC
	[illegible]
	[illegible]

[illegible] polygon [illegible] the virtue of data from the [illegible]. Interface files were produced for all four thematic data [illegible].

[illegible] can be found in [illegible].

2.2 FORMATION OF THE DATA BASE

With completion of the preprocessing stage, the framework for the MC&G data base was established (Figure 2-15). It consisted of several representational files derived from the four original thematic data planes (land use, contours, revisions, and floodplain) and the newly established CF plane. For each of these thematic overlays, a line segment image, a region image, and an interface file were produced. The final processing steps required for completion of the data base entailed the establishment of logical links from files representing the thermatic data overlays to the interface file and polygon file of the CF base. Two procedures were performed: (1) image plane and (2) merging of interface files.

2.2.1 Image Plane Overlay

Image Plane overlay (conventionally referred to as polygon overlay in vector-based systems) is a process which enables the computation of the frequency of occurrence of specific features in one image within the context of recognized regions (i.e., polygons) defined by a second image. The overlay procedure has been utilized in previous applications to derive the frequency of occurrence of land use features within civil regions such as census tracts or city boundaries. The results of the overlay procedure are stored in an IBIS interface file.

Typically, an interface file produced from the overlay of two images contains three columns describing corresponding geographic region labels from the overlaid images in two columns and pixel summations (the number of common pixels) in a third. In the case of the MC&G application, a modified overlay procedure was developed to enable the simultaneous overlay of [illegible] data sets.

Thus, for the MC&G project, the image plane overlay procedure [illegible] combining the attributes of the four thematic overlays with the [illegible]. The resultant interface file contained six columns of [illegible] (Table 2-3).

[illegible] the CF plane was derived through the combination of the four [illegible] planes, the resultant image plane overlay file was simply [illegible] (Table 2-3)[6]. For example, the characteristics of region 25 of [illegible], which forms the upper right-hand corner of the data base, will be [illegible] in detail. The bounding features controlling the spatial extent of [illegible] were line segments from the land use data plane and the edge of the [illegible]. The feature area of regions within the other three data planes [illegible] beyond the region 25 borders. The corresponding region label [illegible] region 25 for columns 2 through 5 in the image plane overlay file [illegible] the region code for each thematic overlay was 13 for the land use [illegible], 11 for the contour map, [illegible] for the floodplain image, and 1 for the land [illegible] image. Additionally, [illegible] column 6 of the interface file, it is [illegible] 1807 pixels were contained in that CF region. The interface file [illegible] the image plane overlay process contained [illegible] entries in all [illegible] all [illegible].

---

[6] [illegible] Appendix [illegible], Figure [illegible].

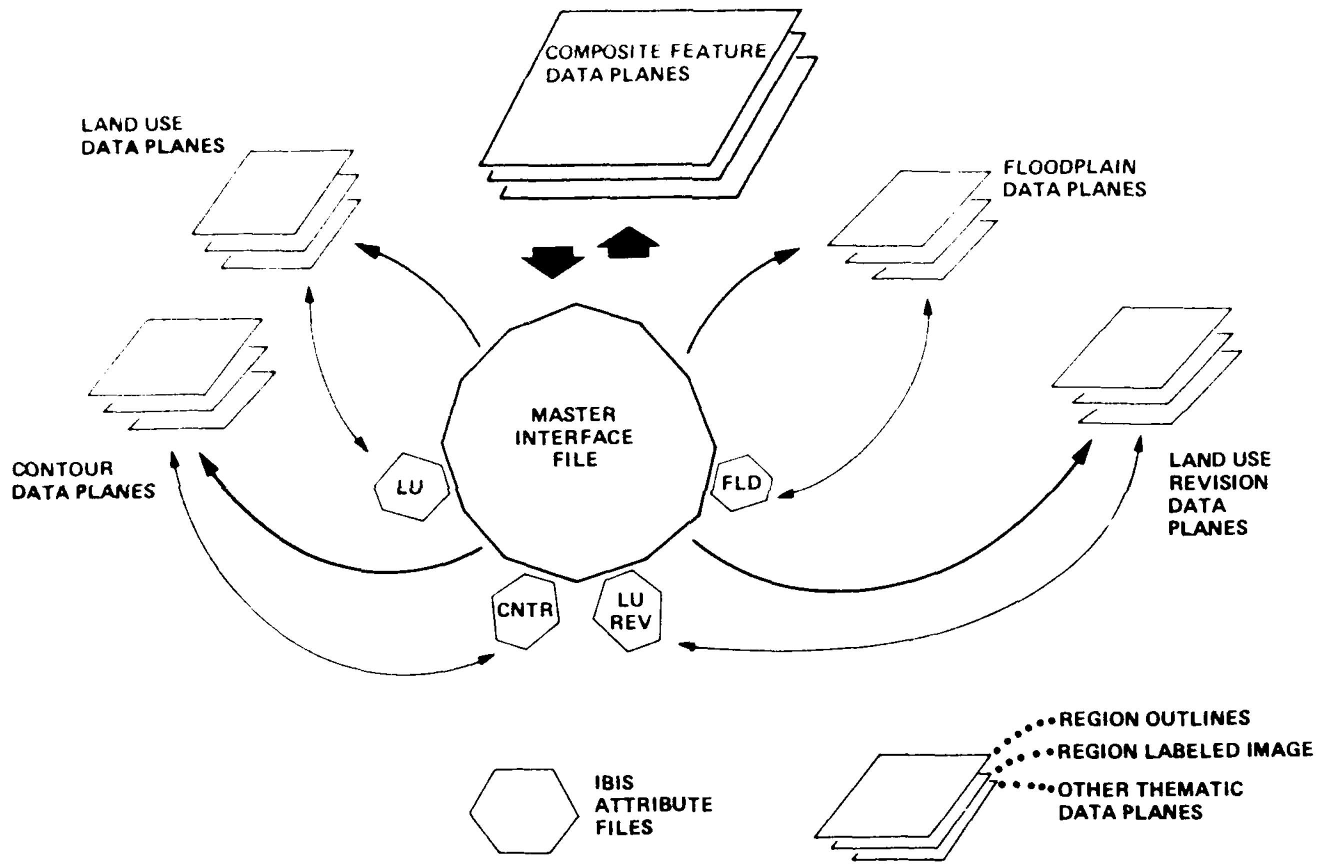


Figure 2-15. Schematic Diagram Depicting the MC&G Data Base (Several sets of image planes and attribute files are all interrelated in the MC&G data base.)

Table 2-3. Column Features of the Image Plane Overlay Interface File

Column	Contents
1	Region identification code: CF data base
2	Corresponding region code: Land use
3	Corresponding region code: 100 foot contours
4	Corresponding region code: 100 year flood plain
5	Corresponding region code: Land use revisions
6	Pixel summations for region "n" of CF data base

[illegible] Merging of Interface Files

Without provision for determining what attribute label polygon [illegible] in the land use image, for example, little can be understood about the composition of region 1 of the composite feature image. By merging label information from the four centroid interface files with the image plane overlay interface file, a new composite interface file was produced which is more useful to data base operations.

Table 2-4. Partial Listing of Data Plane Overlay Interface File

Column:	(1)	(2)	(3)	(4)	(5)	(6)
Contents:	GEOREF	LU	CONTOUR	FLOOD	REVISION	COUNTS
	1	1	1	1	1	109
	2	2	1	1	1	209
	3	3	1	1	1	52030
	.	.	.	.	.	...
	25	13	11	4	1	1302
	.	.	.	.	.	...
	763	229	73	1	1	359
	764	229	5	1	1	82

[illegible] Final Modifications to the Master Interface File

Two final augmentations to the interface file were required to form [illegible] interface file. Further information was required to support query [illegible] as outlined in the project description.

First, since areal measurements of polygons would be required in [illegible] to pixel counts, acreage, and square mile calculations were performed [illegible] two additional columns of the interface file. The areal [illegible] were performed through the use of the IBIS mathematical function [illegible]. [illegible] allows the user to interact with the interface file through [illegible] mathematical notation.

The second augmentation was performed to enable direct querying of the interface file. Since IBIS query operations require numerical codings for centroid or attribute labels, the alphabetic labels contained in the interface file had to be converted to a numerical format. This required the addition of four additional columns of data.

The final interface file, containing tabular information pertaining to (1) three plane overlay, (2) centroid-match, (3) pixel counts, (4) areal calculations, and (5) numerical labels was two complete. The file will be referred to as the master interface file[7]. The master interface file contains twenty columns of information (Table 2-5).

[illegible] ADDITION OF LANDSAT AND DIGITAL TERRAIN DATA TO THE MC&G DATA BASE

One of the research objectives was to demonstrate that Landsat imagery could be registered to the MC&G data base. It was also proposed that digital terrain data would be registered as well. However, due to extreme scale differences between the digital imagery and the data base, the addition of the digital imagery to the data base proved to be a useless exercise. The MC&G data base was digitized at a scale of resolution of 20 x 20 feet (7 x 7m). Since Landsat data has a nominal scale of resolution of 80 meters, it was determined that the scale difference between the two types of data was 1:13. The scale difference was so extreme that if the Landsat data were registered to the data base, only 5796 pixels (a region 69 by 84 pixels) would be represented in the data base (approximately 900 x 1200 pixels). Such little information would be added to the data base that it would be considered meaningless for any query operations. Thus the Landsat data was not processed. Other digital imagery covering the study area was not readily available at JPL.

Although Landsat imagery could not be registered to the MC&G data base, the potential has been demonstrated quite effectively in other research programs. [illegible], Landsat and census data were combined to study urban [illegible]. If the spatial extent of the MC&G data base were extended to cover a much larger area, the registration of Landsat imagery to the data base would be possible.

---

[7] A complete listing of the master interface file can be found in Appendix B [illegible].

Figure 2-16. Image Showing Results of Concatenation of Landsat and Map Data in a Data Base
(Landsat and Census Tract data registered to a common Georeference base)

Table 2-5. Composition of Master Interface File

COLUMN	Use	
1	Georeference data base polygon numbers	
2	Number of pixels per polygon	
3	-unused-	
4	Land use	Corresponding polygon code from these data planes
5	Contours	
6	Flood plain	
7	Revisions	
8	Number of acres (computed)	
9	Number of square miles (computed)	
10	-unused-	
11	Land use	Alphabetic labels for polygons described in columns 4-7
12	Contours	
13	Flood plain	
14	Revisions	
15	Land use	Numeric labels for alphabetic labels described in columns 11-14
16	Contours	
17	Flood plain	
18	Revisions	
19	-reserved for query-	
20	-reserved for query-	

Number of entries: 764

SECTION 3

3.0 TABULATION AND QUERY OPERATIONS

The completed MC&G database can be utilized for a variety of data processing operations to obtain information about the Healdsburg study area which the data base represents. The most basic of these operations is the calculation and reporting of areal measurements for polygonal regions comprising the CF data base, or from the other polygon data planes within the data base. More complex operations such as questioning, or querying, the data base are also possible. In addition to obtaining tabular reports as a result of specific queries, thematic maps depicting the spatial distribution of features identified by the query can be produced on request.

The most important data set for tabulation and query operations is the master interface file. It contains valuable linking information describing the association between geographic regions comprising the CF data plane and all other raster-region image planes. Both numeric and symbolic labels describing qualitative attributes of each geographic region in the CF data base are stored as well. These labels provide a natural mechanism for linking the data base to the Healdsburg study area. Additional data such as histograms (i.e., pixel summations by geographic region) which were obtained during the image plane overlay procedure are stored in the master interface file.

Image planes are not required for simple tabulation, as all data (labels, codes, and pixel counts) pertinent to the operation have been previously encoded in the master interface file. However, several image planes can be required for query operations. The most important image plane utilized in querying is the CF data plane. Other image files which are frequently useful include geographic feature outline and region identification images of the four thematic overlays. The outline images can be used as a spatial referencing tool, providing a cognitive association to the Healdsburg study area, while the various region identified images can be directly queried through the master interface file.

3.1 AREAL TABULATION

The master interface file contains most important information needed to compute areal measurements for geographic regions. For each geographic region comprising the CF base, its identification code (paint number) is found in column 1 of the interface file, while the numbers of pixel units contained in each respective region are stored in column 2. The pixel counts were stored in the master interface file during the image plane overlay step covered in Section 2.

3.1.1 Calculation

Since the pixel counts (column 2) for each region in the CF data plane (column 1) were calculated previously, the calculation of area in specific unit measures, such as acres, hectares, or square miles, was a simple

operation involving the multiplication of pixel counts by computed scale conversion factors[8]. The scale conversion factors can be plugged into simple algebraic expressions:

(1) ACRE = NPIXELS * 0.00182736 or
(2) SQMI = NPIXELS * 0.000014348,

where NPIXELS is the pixel count for any given geographic region, and 0.00182736 and 0.000014348 are respective areal scale conversion factors for acres and square miles. The results of the calculations, ACRE and SQMI, were stored in columns 8 and 9 of the master interface file and were printed with the execution of an interface file listing program (Table 3-1).

3.1.2 Aggregation by Land Use Codes

The tabular listing referenced only by region identification codes of the CF data plane was only marginally useful. It was hard to interpret the meaning of the reported information in any context with reference to the study area. A more useful analysis tool would be obtained if areal calculations were lined to specifically known thematic features from the source maps. For example, the land use overlay could be effectively used for that purpose, and such a report was easily generated with information stored in the master interface file. Columns 4 and 11 contain important attribute labeling information for the generation of areal tabulations aggregated by land use codes.

The process of obtaining a tabular report of areal coverage by a specific topical theme, such as land use, involves some reordering and aggregation of data components in the master interface file. Since the formation of most complete land use regions would require the merging of several adjacent regions in the CF data plane, attributes of those smaller polygons had to be merged in the interface file as well. First, the file was sorted numerically by ordering region identification codes (column 4) representing coding assignments made to the land use region labeled image during the PAINT process. That operation caused a juxtaposition of all data representing specific land use codes to adjacent rows of the interface file (Table 3-2). Then pixel counts from all CF data plane regions which collectively represented specific land use regions were aggregated to obtain total areal definitions for all independent land use regions with the data base. With the addition of alphabetic attribute labels for the land use regions (stored in column 11), a final report was produced (Table 3-3).

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[8] As computed earlier, the relative map scale of the data base is 1:240,000, being scaled to 0.1 of the original map base having a scale of 1:24,000. At 1:240,000 1 pixel equals 9.18 x 10(-3) acres or 1.43 x 10(-5) square miles. In conventional representation 1 acre equals 108.9 pixels, and 1 square mile covers 69,696 pixels. The linear resolution of a pixel is 20 x 20 feet to cover 400 square feet. The total study area, 1,008,000 pixels, covers 14.46 square miles.

Table 3-1. A Portion of the Tabular Report Depicting Areal Calculations for the Composite Feature Data Plane (The report was generated from the master interface file.)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

LAND USE POLYGON CODE	GEOREF REGION CODE	-- AREAL COVERAGE --		
		PIXELS	ACRES	SQ MILES
1	1	109	1.00	0.00156
2	2	209	1.92	0.00300
3	3	52030	477.78	0.74652
4	4	700	6.43	0.01004
5	5	385	3.54	0.00552
5	6	318	2.92	0.00456
6	7	19199	176.30	0.27547
6	8	64	0.59	0.00092
6	9	13690	125.71	0.19642
6	10	2154	19.78	0.03091
7	11	19591	179.90	0.28109
8	12	1601	14.70	0.02297
8	13	8	0.07	0.00011
8	14	11	0.10	0.00016
8	15	1311	12.04	0.01881
8	16	35	0.32	0.00050
9	17	1992	18.29	0.02858
10	18	401	3.68	0.00575
10	19	8	0.07	0.00011
10	20	124	1.14	0.00178
9	21	39	0.36	0.00056
11	22	476	4.37	0.00683
11	23	3973	36.48	0.05700
12	24	443	4.07	0.00636
13	25	1302	11.96	0.01868
6	26	13	0.12	0.00019
8	27	12	0.11	0.00017
8	28	271	2.49	0.00389
9	29	1203	11.05	0.01726
11	30	73	0.67	0.00105
9	31	616	5.66	0.00884
10	32	366	3.36	0.00525
14	33	2667	24.49	0.03827
15	34	799	7.34	0.01146
6	35	13805	126.77	0.19807
8	36	112	1.03	0.00161
16	37	71	0.65	0.00102
9	38	468	4.30	0.00671
6	39	113	1.04	0.00162
17	40	1180	10.84	0.01693
10	41	53	0.49	0.00076
8	42	38	0.35	0.00055
6	43	464	4.26	0.00666
16	44	162	1.49	0.00232
11	45	313	2.87	0.00449
17	46	85	0.78	0.00122

Table 3-2. Interface File Reordered to Place Each Unique Land Use Region Label Code in Adjacent Rows of the Interface File (partial listing)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

LAND USE POLYGON CODE	GEOREF REGION CODE	-- AREAL COVERAGE --		
		PIXELS	ACRES	SQ MILES
1	1	109	1.00	0.00156
2	2	209	1.92	0.00300
3	3	52030	477.78	0.74652
3	233	156	1.43	0.00224
3	244	20	0.18	0.00029
3	248	67	0.62	0.00096
3	249	9	0.08	0.00013
3	256	13	0.12	0.00019
3	279	10	0.09	0.00014
3	302	757	6.95	0.01086
3	303	21	0.19	0.00030
3	306	13	0.12	0.00019
3	321	64	0.59	0.00092
3	324	11	0.10	0.00016
3	326	2081	19.11	0.02986
3	327	24	0.22	0.00034
3	331	61	0.56	0.00088
3	333	38	0.35	0.00055
3	343	26	0.24	0.00037
3	344	155	1.42	0.00222
3	358	35	0.32	0.00050
3	362	46	0.42	0.00066
3	165	93	0.85	0.00133
4	4	700	6.43	0.01004
5	5	385	3.54	0.00552
5	6	318	2.92	0.00456
6	102	14	0.13	0.00020
6	203	35	0.32	0.00050
6	105	797	7.32	0.01144
6	97	56	0.51	0.00080
6	98	70	0.64	0.00100
6	176	16	0.15	0.00023
6	96	1389	12.75	0.01993
6	180	251	2.30	0.00360
6	35	13805	126.77	0.19807
6	181	26	0.24	0.00037
6	154	27	0.25	0.00039
6	187	66	0.61	0.00095
6	39	113	1.04	0.00162
6	107	62	0.57	0.00089
6	188	12	0.11	0.00017
6	190	99	0.91	0.00142
6	43	464	4.26	0.00666
6	133	121	1.11	0.00174
6	87	39	0.36	0.00056
6	109	103	0.95	0.00148

Table 3-3. Listing with Attribute Labels to Aid Interpretation of the Interface File Report (partial listing)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IRIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

- POLYGON -		-- AREAL COVERAGE --		
CODE	LABEL	PIXELS	ACRES	SQ MILES
1	UIS	109	1.00	0.00156
		109	1.00	0.00156
2	UCR	209	1.92	0.00300
		209	1.92	0.00300
3	URS	52030	477.78	0.74652
3	URS	156	1.43	0.00224
3	URS	20	0.18	0.00029
3	URS	67	0.62	0.00096
3	URS	9	0.08	0.00013
3	URS	13	0.12	0.00019
3	URS	10	0.09	0.00014
3	URS	757	6.95	0.01086
3	URS	21	0.19	0.00030
3	URS	13	0.12	0.00019
3	URS	64	0.59	0.00092
3	URS	11	0.10	0.00016
3	URS	2081	19.11	0.02986
3	URS	24	0.22	0.00034
3	URS	61	0.56	0.00088
3	URS	38	0.35	0.00055
3	URS	26	0.24	0.00037
3	URS	155	1.42	0.00222
3	URS	35	0.32	0.00050
3	URS	46	0.42	0.00066
3	URS	93	0.85	0.00133
		55730	511.75	0.79961
4	RT	700	6.43	0.01004
		700	6.43	0.01004
5	UCV	385	3.54	0.00552
5	UCV	318	2.92	0.00456
		703	6.46	0.01009
6	URS	14	0.13	0.00020
6	URS	35	0.32	0.00050
6	URS	797	7.32	0.01144
6	URS	56	0.51	0.00080
6	URS	70	0.64	0.00100

Several other themes could be represented through sorting and aggregating of information in the interface file. For example, one useful report could be derived from reporting all unique thematic combinations between the four map base overlays (Table 3-5). The data processing steps used to obtain that report were similar to those used in the previous example. The operation involved the utilization of key label information which described the attributes of the four thematic overlays found in columns 11-18 of the master interface files.

3.[illegible] QUERY OPERATIONS

Through analysis of tabular listing such as those produced for the previous section, a great deal of information can be learned about the Healdsburg region. The proportional coverage of specific land use or topographic features can be determined. Even the size and types of regions which could be subject to severe flooding during a 100-year flood could be determined with some effort. However, the actual value of the information and the utility of the report are limited due to the cumbersome nature of the report structure and [illegible] of the data sets involved. The missing elements needed to make such information in the data base really useful are selection and spatial referencing. With the report procedure previously described, there is no way to readily determine what conditions specifically exist, and it is impossible to determine where specific features of interest exist without cumbersome analysis of the land use map. Furthermore, there is no mechanism to provide a spatial context to the analysis.

A query operation has been developed to provide an easy method for obtaining selected facts from an IBIS data base in both an ordered listing form and additionally in a spatial context. Since many disparate data sources may be integrated in a geographic data base, topical inquiries, some of which may be [illegible] in structure that they could not be easily perceived through traditional map interpretation, can be constructed to learn about the nature [illegible] of features stored in the data base.

Queries are posed to the data base in the form of a question. The answer to the question is output in both tabular and map form. Two primary data sets [illegible] query are the master interface file and the georeference base. [illegible] utilities, including a mathematical function generator and [illegible] mapping routine (choropleth type) are utilized.

[illegible] Simple Queries

The purpose of the query is to learn some facts about the study area through questioning of the data base. For example, a question could be posed:

Which areas were encoded with land use code ACC?

Unfortunately, IBIS computer communications capabilities have not been sufficiently developed to enable the posing of such a question in normal grammatical English or even a pseudo-text language. Instead a special language, one that can be interpreted by the computer, has been developed.

Table 3-4. All Unique Data Base Combinations Can Be Reported (partial listing)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

AGGREGATION BY ALL UNIQUE THEMATIC COMBINATIONS

	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
INDEX	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
1	ACC	50	BELO		9279	85.21	0.13313
2	ACC	50	ABOV		12596	115.67	0.18073
3	ACC	50	ABOV	ACC	1188	10.91	0.01705
4	ACC	50	ABOV	UIS	940	8.63	0.01349
5	ACC	150	ABOV		15027	137.99	0.21561
6	ACP	50	BELO		750	6.89	0.01076
7	ACP	50	BELO	AVV	125	1.15	0.00179
8	ACP	50	ABOV		7538	69.22	0.10815
9	ACP	50	ABOV	AVV	1001	9.19	0.01436
10	ACP	150	ABOV		74268	681.98	1.06559
11	ACP	150	ABOV	URS	1827	16.78	0.02621
12	ACP	250	ABOV		36630	336.36	0.52557
13	ACP	250	ABOV	URS	3328	30.56	0.04775
14	ACP	350	ABOV		12974	119.14	0.18615
15	ACP	450	ABOV		7301	67.04	0.10475
16	ACP	550	ABOV		5545	50.92	0.07956
17	ACP	650	ABOV		6963	63.94	0.09990
18	ACP	750	ABOV		3195	29.35	0.04586
19	AF	50	ABOV		3536	32.47	0.05073
20	AF	150	ABOV		2094	19.23	0.03004
21	AF	250	ABOV		385	3.54	0.00554
22	AF	650	ABOV		840	7.71	0.01205
23	AVF	50	BELO		34024	312.43	0.48817
24	AVF	50	BELO	AVV	261	2.40	0.00374
25	AVF	50	ABOV		61527	564.98	0.88279
26	AVF	50	ABOV	ACC	22	0.20	0.00032
27	AVF	50	ABOV	AVV	2765	25.39	0.03967
28	AVF	50	ABOV	UIS	1918	17.61	0.02752
29	AVF	150	BELO		1332	12.23	0.01911
30	AVF	150	ABOV		34011	312.31	0.48799
31	AVF	150	ABOV	URS	4059	37.27	0.05824
32	AVF	250	ABOV		2565	23.56	0.03682
33	AVF	250	ABOV	URS	249	2.29	0.00357
34	AVF	350	ABOV		573	5.26	0.00822
35	AVV	50	BELO		70181	644.45	1.00695
36	AVV	50	BELO	ACC	25	0.23	0.00036
37	AVV	50	BELO	AVV	117	1.07	0.00168
38	AVV	50	ABOV		48543	445.76	0.69649
39	AVV	50	ABOV	ACC	4309	39.57	0.06183
40	AVV	50	ABOV	AVV	1931	17.73	0.02771
41	AVV	50	ABOV	UIS	526	4.83	0.00755
42	AVV	150	BELO		248	2.28	0.00356
43	AVV	150	ABOV		45201	415.07	0.64854

[illegible], FORTRAN-type functional and algebraic expressions are utilized. To query the data base to find all lands with code ACC, a query statement is formulated:[9]

(C15 .EQ. 1),

[illegible] where C15 represents column 15 of the master interface file where [illegible] land use codes were stored; .EQ. as in FORTRAN is the check for logical [illegible], and 1, in this case, represents the numerical label for land cover [illegible]. The computer has been asked to identify all entries in the master [illegible] file where in column 15 the value 1 (ACC) has been stored. Inter[illegible], the computer treats the query as a binary operation. It interprets the [illegible]: if column 15 equals 1, assign the value 1, or true, to the result of [illegible] operation; and if column 15 does not equal 1, assign the value 0, or false, [illegible] result of the operation.

[illegible] same query is processed on each and every row in the interface [illegible]. [illegible] all true entries are identified, they are reported (Table 3-[illegible]) [illegible] mapped (Figure 3-1). Since simple referencing features [illegible] to the analyst in locating the position of queried features in [illegible], graphic overlays, such as the land use map outline (Figure 3-2) [illegible] regions comprising the CF data base (Figure 3-3) can be added [illegible] product.

[illegible] Complex Queries

[illegible] can be designed to extract information from the columns [illegible] data planes of the data base as well. For example, to [illegible] between 300 and 400 feet (91.[illegible] and 122 m), the query [illegible]

(C16 .EQ. 3),

[illegible] the column where topographic information was stored and [illegible] the elevation range 300-400 feet. Again .EQ. [illegible].

[illegible] may request the identification of topographic zones [illegible] interval, such as a range of 300 feet, a more complex [illegible] formulated to ask the same question:

[illegible] .AND. (C16 .LE. 4),

[illegible] queries to be made with numerical labels. [illegible] both a numerical code (column 15) and [illegible] (column 11). Once a query is completed, the [illegible] for tabular listings and other printing [illegible]. [illegible] numerical label based [illegible]. [illegible] label for the remaining [illegible] in a similar manner.

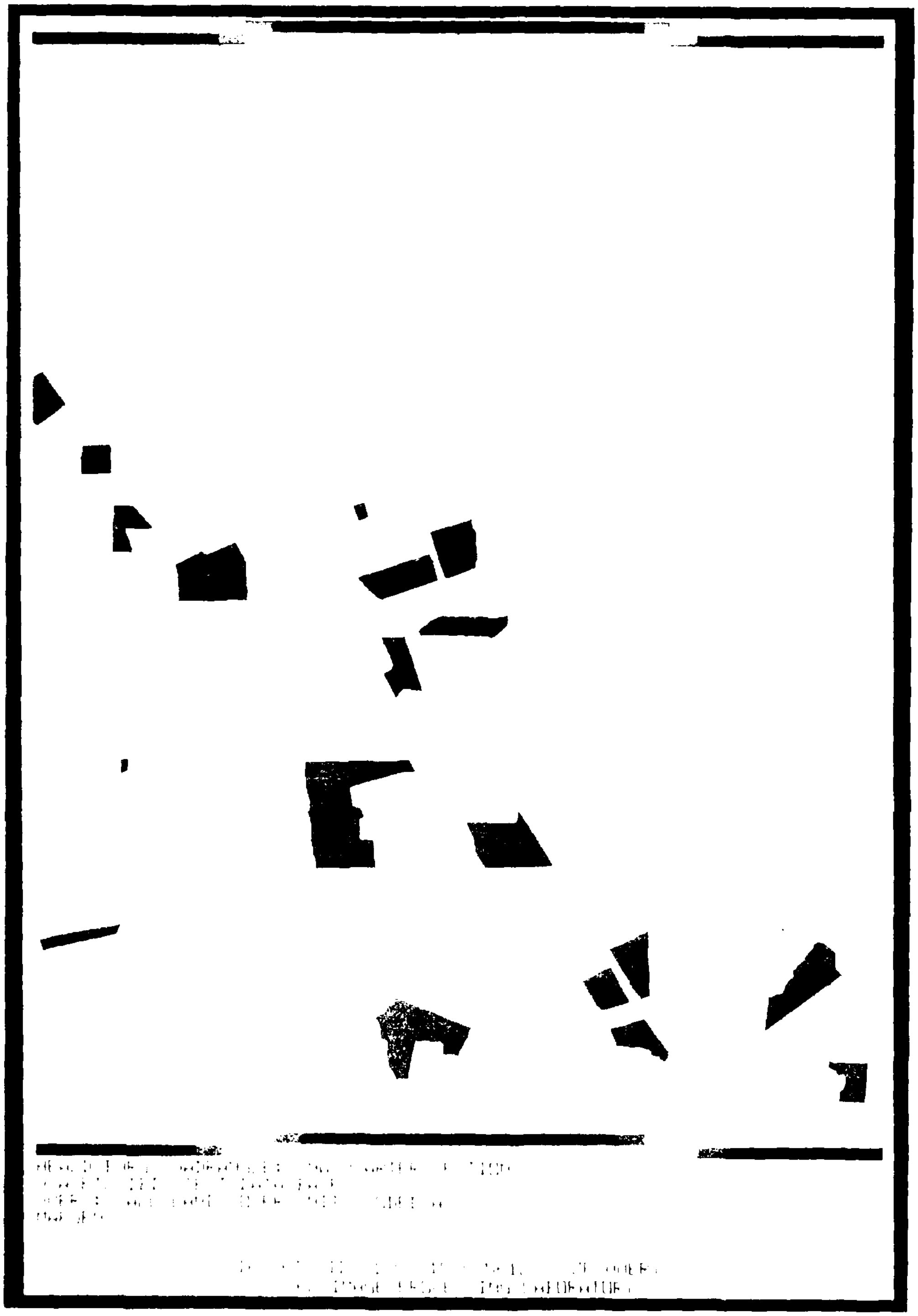
[illegible] of All Land Use Areas Encoded with [illegible]

[illegible] QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240.000 1 PIXEL = 400 SQ FT

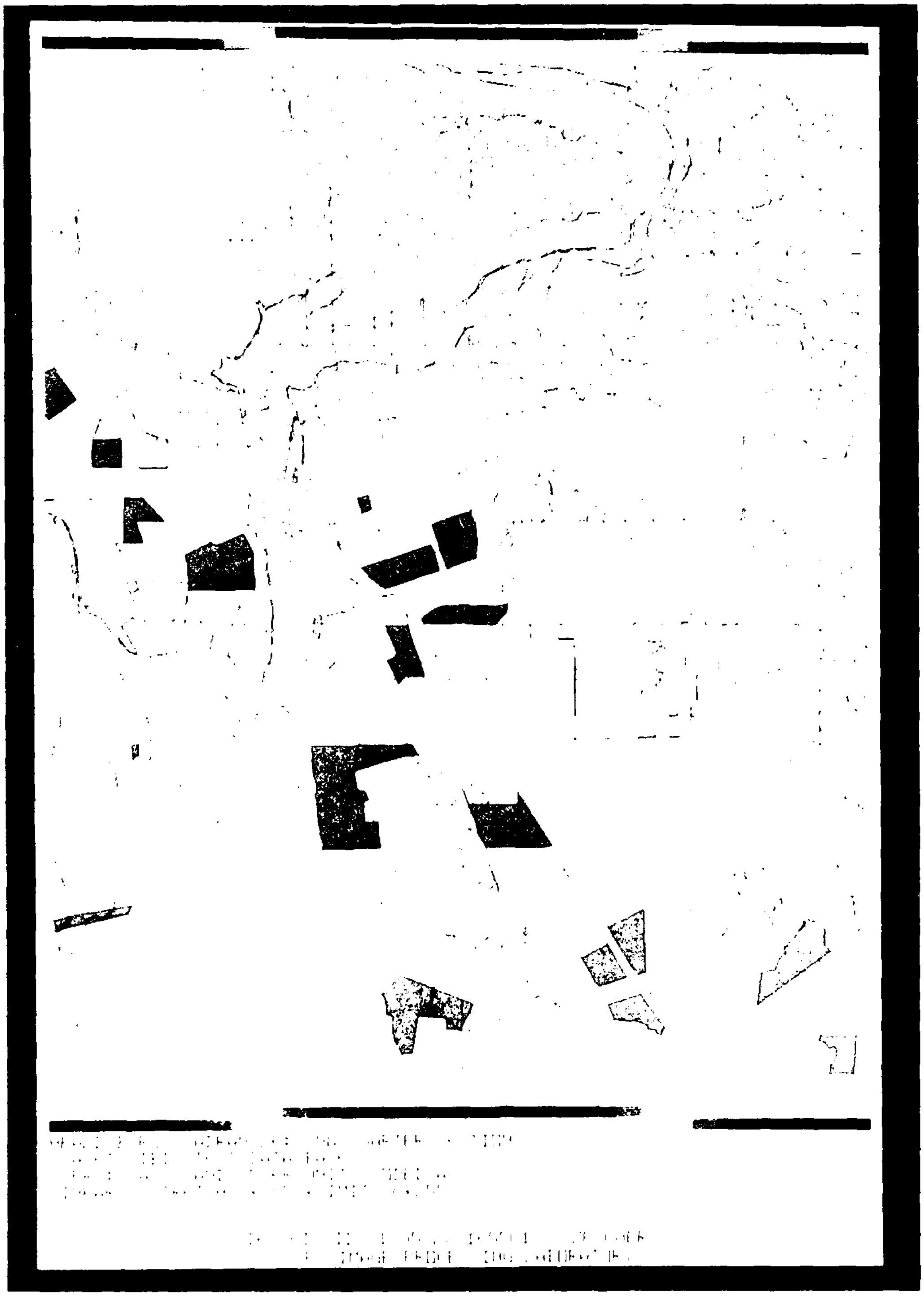
THIS TEST DATA BASE FOR
US ARMY. ENGINEER TOPOGRAPHIC LABORATORIES

QUERY: ALL LAND COVER UNITS CODED ACC

LAND USE REGION	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
[illegible]	ACC	50	ABOV		1222	11.22	0.01753
77	ACC	50	ABOV	UIS	940	8.63	0.01349
86	ACC	50	ABOV		197	1.81	0.00283
87	ACC	50	ABOV	ACC	1188	10.91	0.01705
90	ACC	50	ABOV		2144	19.69	0.03076
[illegible]	ACC	50	ABOV		3687	33.86	0.05290
101	ACC	50	ABOV		2190	20.11	0.03142
105	ACC	150	ABOV		1689	15.51	0.02423
113	ACC	50	ABOV		134	1.23	0.00192
115	ACC	150	ABOV		1431	13.14	0.02053
140	ACC	50	BELO		6112	56.12	0.08769
140	ACC	50	ABOV		982	9.02	0.01409
140	ACC	150	ABOV		91	0.84	0.00131
141	ACC	50	ABOV		100	0.92	0.00143
155	ACC	50	ABOV		149	1.37	0.00214
155	ACC	150	ABOV		3178	29.18	0.04560
173	ACC	50	ABOV		447	4.10	0.00641
173	ACC	50	BELO		318	2.92	0.00456
175	ACC	150	ABOV		144	1.32	0.00207
174	ACC	150	ABOV		1733	15.91	0.02487
180	ACC	150	ABOV		2953	27.12	0.04237
187	ACC	150	ABOV		1308	12.01	0.01877
197	ACC	50	BELO		2849	26.16	0.04088
197	ACC	50	ABOV		1344	12.34	0.01928
200	ACC	150	ABOV		1357	12.46	0.01947
215	ACC	150	ABOV		1143	10.50	0.01640
					39030	358.40	0.56000



[illegible] Land Use Outline Map as [illegible]



where in this case the computer is asked to find all regions with topographic relief codes greater than 2 but less than 4. Again the result of the query is binary, either true or false depending on whether the topographic relief code is between 2 and 4 exclusively. As in the previous example, a tabular listing (Table 3-6) and a distribution map (Figure 3-4) were produced.

3.2.3 Multiple Column Queries

Queries are not limited to asking questions from single columns in the master interface file. Queries can be formulated to involve multiple columns as well. For example, to map all lands within the flood plain but below 100 feet (30.5 m), the query statement is formulated:

(C17 .EQ. 0 .AND. C16 .LT. 1).

The question which has been posed is to identify all regions having a code of 0 (within the flood plain) in column 17 and all regions less than 1 (below 100 feet) in column 16. The results of this query were reported (Table 3-7) and mapped (Figure 3-5). Of course very complex queries could be formulated. Some of these will require several steps for completion. For example to show all land use polygons which have been altered by revision, the query starts with an easy expression:

(C18 .NE. 0),

but becomes complex in subsequent interface file manipulation and merging exercises involved to determine which land use polygon codes (stored in column 4) have been partially or completely altered by land use revision. As in other queries, a tabulation (Table 3-8) and distribution map (Figure 3-6) were produced.

Table 3-6. Tabular Report of All Areas Between 300-400 feet in Elevation

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

QUERY: ALL AREAS BETWEEN 300 AND 400 FT

LAND USE REGION	DATA PLANE ATTRIBUTES: LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	AREAL COVERAGE: PIXELS	ACRES	SQ MILES
6	UPS	350	ABOV		64	0.59	0.00092
6	URS	350	ABOV		13894	127.58	0.19935
6	UPS	350	ABOV		50	0.46	0.00072
[illegible]	R	350	ABOV		1203	11.05	0.01726
10	AVV	350	ABOV		3	0.[illegible]7	0.00011
10	AVV	350	ABOV		124	1.14	0.00178
10	AVV	350	ABOV		366	3.36	0.00525
11	AVF	350	ABOV		573	5.26	0.00822
19	FO	350	ABOV		3349	30.75	0.04805
22	FO	350	ABOV		206	1.89	0.00296
26	R	350	ABOV		822	7.55	0.01179
29	UPS	350	ABOV		504	4.63	0.00723
36	FO	350	ABOV		6093	55.95	0.08742
[illegible]	R	350	ABOV		2126	19.52	0.03050
51	R	350	ABOV		7725	70.94	0.11084
[illegible]	R	350	ABOV		979	8.99	0.01405
[illegible]	ACP	350	ABOV		3737	34.32	0.05362
[illegible]	AVV	350	ABOV		301	2.76	0.00432
110	ACP	350	ABOV		9204	84.52	0.13206
110	ACP	350	ABOV		33	0.30	0.00047
124	BT	350	ABOV		835	7.67	0.01198
124	BT	350	ABOV		94	0.86	0.00135
127	[illegible]	350	ABOV		761	6.99	0.01092
137	[illegible]	350	ABOV		1593	14.63	0.02286
					54644	501.78	0.78403

Table 3-7. Tabular Report of All Areas within the Floodplain and below 100 feet (1 of 2)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

QUERY: ALL LANDS WITHIN FLOODPLAIN AND BELOW 100 FT

LAND USE REGION	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
3	URS	50	BELO		1191	10.94	0.01709
6	URS	50	BELO		3412	31.33	0.04896
7	WS	50	BELO		19591	179.90	0.28109
8	FO	50	BELO		1639	15.05	0.02352
9	R	50	BELO		35	0.32	0.00050
17	URS	50	BELO		392	3.60	0.00562
19	FO	50	BELO		153	1.40	0.00220
29	URS	50	BELO		425	3.90	0.00610
36	FO	50	BELO		354	3.25	0.00508
40	R	50	BELO		223	2.05	0.00320
41	AVF	50	BELO		12	0.11	0.00017
42	AVF	50	BELO		1196	10.98	0.01716
43	AVV	50	BELO		1223	11.23	0.01755
44	AVF	50	BELO		3174	29.15	0.04554
45	BT	50	BELO		449	4.12	0.00644
50	AVF	50	BELO		1796	16.49	0.02577
52	UUT	50	BELO		201	1.85	0.00288
58	LR	50	BELO		445	4.09	0.00638
61	UES	50	BELO		3843	35.29	0.05514
62	URS	50	BELO		584	5.36	0.00838
63	AVF	50	BELO		211	1.94	0.00303
63	AVF	50	BELO	AVV	97	0.89	0.00139
66	UOP	50	BELO		869	7.98	0.01247
70	UIS	50	BELO		686	6.30	0.00984
73	URH	50	BELO		121	1.11	0.00174
76	RES	50	BELO		781	7.17	0.01121
78	URS	50	BELO		505	4.64	0.00725
81	URS	50	BELO		297	2.73	0.00426
83	VV	50	BELO		658	6.04	0.00944
85	LR	50	BELO		333	3.06	0.00478
88	AVV	50	BELO	ACC	25	0.23	0.00036
91	WS	50	BELO		700	6.43	0.01004
91	WS	50	BELO	ACC	49	0.45	0.00070
92	LR	50	BELO		850	7.81	0.01220
93	AVF	50	BELO		366	3.36	0.00525
94	URS	50	BELO		74	0.68	0.00106
95	UUT	50	BELO		1290	11.85	0.01851
96	UOO	50	BELO		486	4.46	0.00697
97	LR	50	BELO		3930	36.09	0.05639
100	AVF	50	BELO		3544	32.54	0.05085
102	AVV	50	BELO	AVV	117	1.07	0.00168
103	AVF	50	BELO		2719	24.97	0.03901

Table 3-7. Tabular Report of All Areas within the Floodplain and below 100 feet (2 of 2)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

QUERY: ALL LANDS WITHIN FLOODPLAIN AND BELOW 100 FT

LAND USE REGION	DATA PLANE ATTRIBUTES: LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	AREAL COVERAGE: PIXELS	ACRES	SQ MILES
103	AVF	50	BELO	AVV	164	1.51	0.00235
104	ACP	50	BELO	AVV	125	1.15	0.00179
106	AVV	50	BELO		48300	443.52	0.69301
108	AVV	50	BELO		3673	33.73	0.05270
109	URS	50	BELO		790	7.25	0.01133
121	WS	50	BELO		830	7.62	0.01191
123	AVV	50	BELO		231	2.12	0.00331
125	AVF	50	BELO		6398	58.75	0.09180
130	AVV	50	BELO		578	5.31	0.00829
132	BBR	50	BELO		183	1.68	0.00263
135	AVV	50	BELO		913	8.43	0.01317
136	UES	50	BELO		4089	37.55	0.05867
138	AVF	50	BELO		400	3.67	0.00574
140	ACC	50	BELO		6112	56.12	0.08769
144	BBR	50	BELO		473	4.34	0.00679
146	AVV	50	BELO		11821	108.55	0.16961
147	UUS	50	BELO		1537	14.11	0.02205
148	AVF	50	BELO		52	0.48	0.00075
151	WO	50	BELO		3269	30.02	0.04690
152	AVF	50	BELO		459	4.21	0.00659
156	AVF	50	BELO		3931	36.10	0.05640
166	ACP	50	BELO		750	6.89	0.01076
172	UUS	50	BELO		24	0.22	0.00034
173	ACC	50	BELO		318	2.92	0.00456
177	AVF	50	BELO		4593	42.18	0.06590
183	AVV	50	BELO		942	8.65	0.01352
186	AVF	50	BELO		1371	12.59	0.01967
189	BBR	50	BELO		2295	21.07	0.03293
197	ACC	50	BELO		2849	26.16	0.04088
199	URS	50	BELO		249	2.29	0.00357
210	LF	50	BELO		827	7.59	0.01167
211	AVV	50	BELO		1626	14.93	0.02333
216	BFO	50	BELO		1441	13.23	0.02068
218	WO	50	BELO		798	7.33	0.01145
222	AVF	50	BELO		3802	34.91	0.05455
229	AVV	50	BELO		869	7.98	0.01247
					176133	1617.37	2.52713

Table 3-8. Tabular Report of All Land Use Areas Altered by Revision

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT
IBIS TEST DATA BASE FOR
US ARMY - ENGINEER TOPOGRAPHIC LABORATORIES

ALL LANDS EFFECTED BY REVISION

LAND USE POLYGON CODE	ATTRIBUTE		UP-DATE CODE	AREAL COVERAGE			
	LAND USE	L USE UPDATE		PIXELS	ACRES	SQ MILES	PERCENT
63	AVF	SAME	1	19717	181.06	0.28290	83.67
63	AVF	UIS	2	1918	17.61	0.02752	8.14
63	AVF	ACC	3	22	0.20	0.00032	0.09
63	AVF	AVV	4	1907	17.51	0.02736	8.09
72	AVV	UIS	2	526	4.83	0.00755	100.00
75	UIS	UIS	2	1006	9.24	0.01443	100.00
77	ACC	UIS	2	940	8.63	0.01349	100.00
87	ACC	ACC	3	1188	10.91	0.01705	100.00
88	AVV	ACC	3	4334	39.80	0.06218	100.00
91	WS	SAME	1	755	6.93	0.01083	92.41
91	WS	ACC	3	62	0.57	0.00089	7.59
102	AVV	AVV	4	2048	18.81	0.02938	100.00
103	AVF	SAME	1	8768	80.51	0.12580	88.68
103	AVF	AVV	4	1119	10.28	0.01606	11.32
104	ACP	AVV	4	1126	10.34	0.01616	100.00
112	AVF	URS	5	4308	39.56	0.06181	100.00
113	AVV	URS	5	954	8.76	0.01369	100.00
114	ACP	URS	5	1712	15.72	0.02456	100.00
120	AVV	URS	5	2266	20.81	0.03251	100.00
126	AVV	URS	5	2100	19.28	0.03013	100.00
129	ACP	URS	5	3443	31.62	0.04940	100.00
131	URS	URS	5	1687	15.49	0.02421	100.00

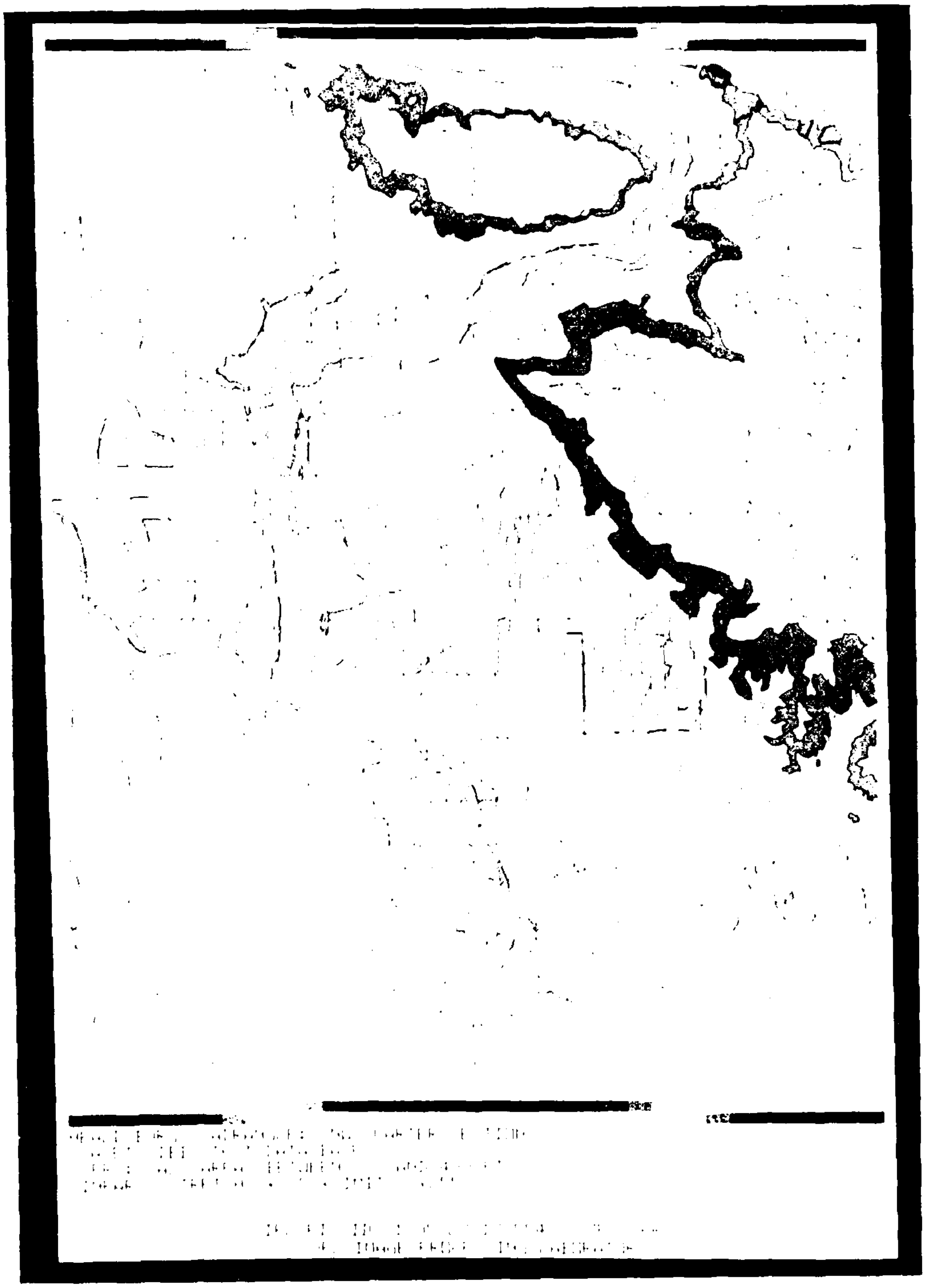


Figure [illegible]. Map Depicting All Areas between [illegible] land use line segments added for [illegible] understanding)

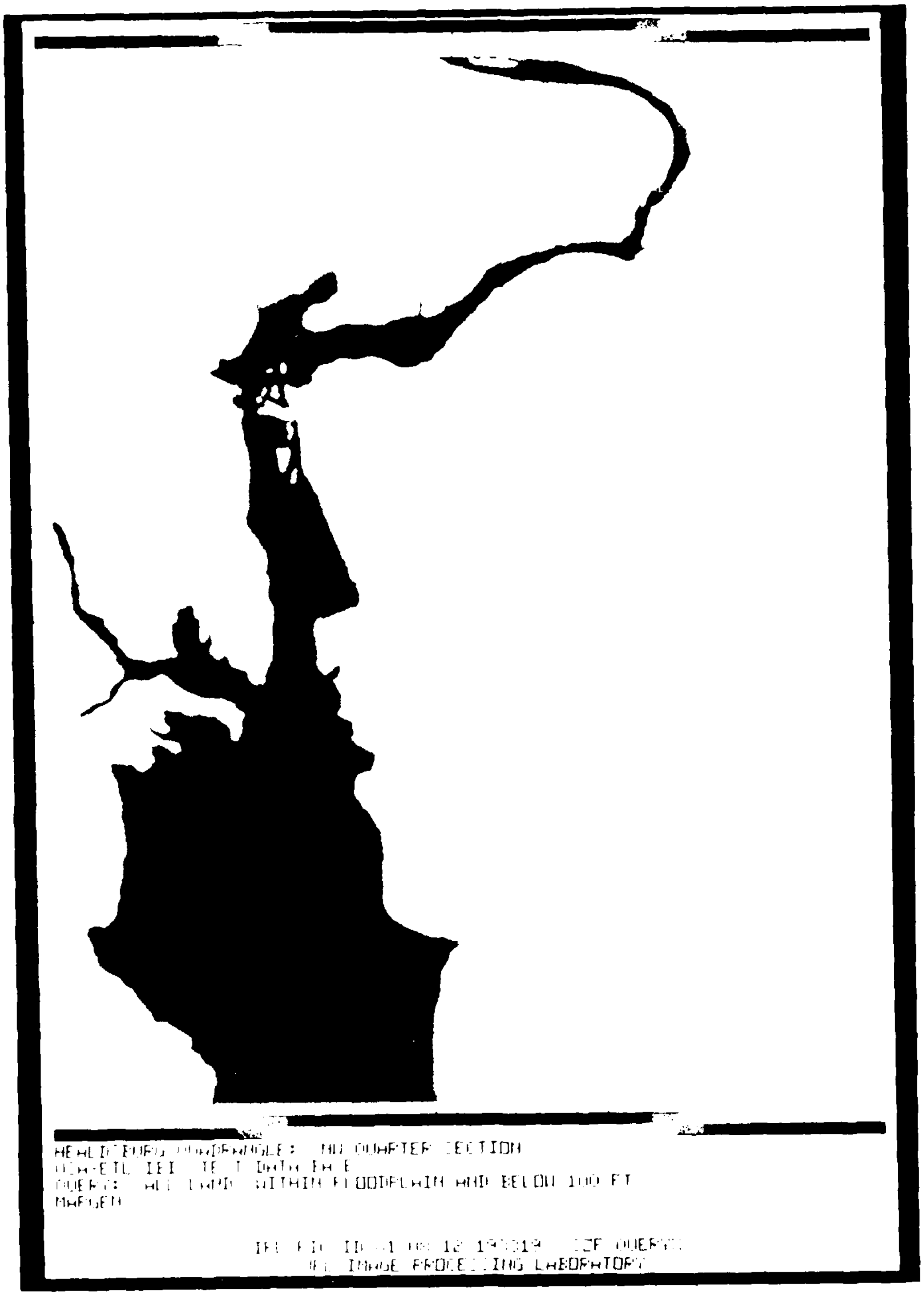
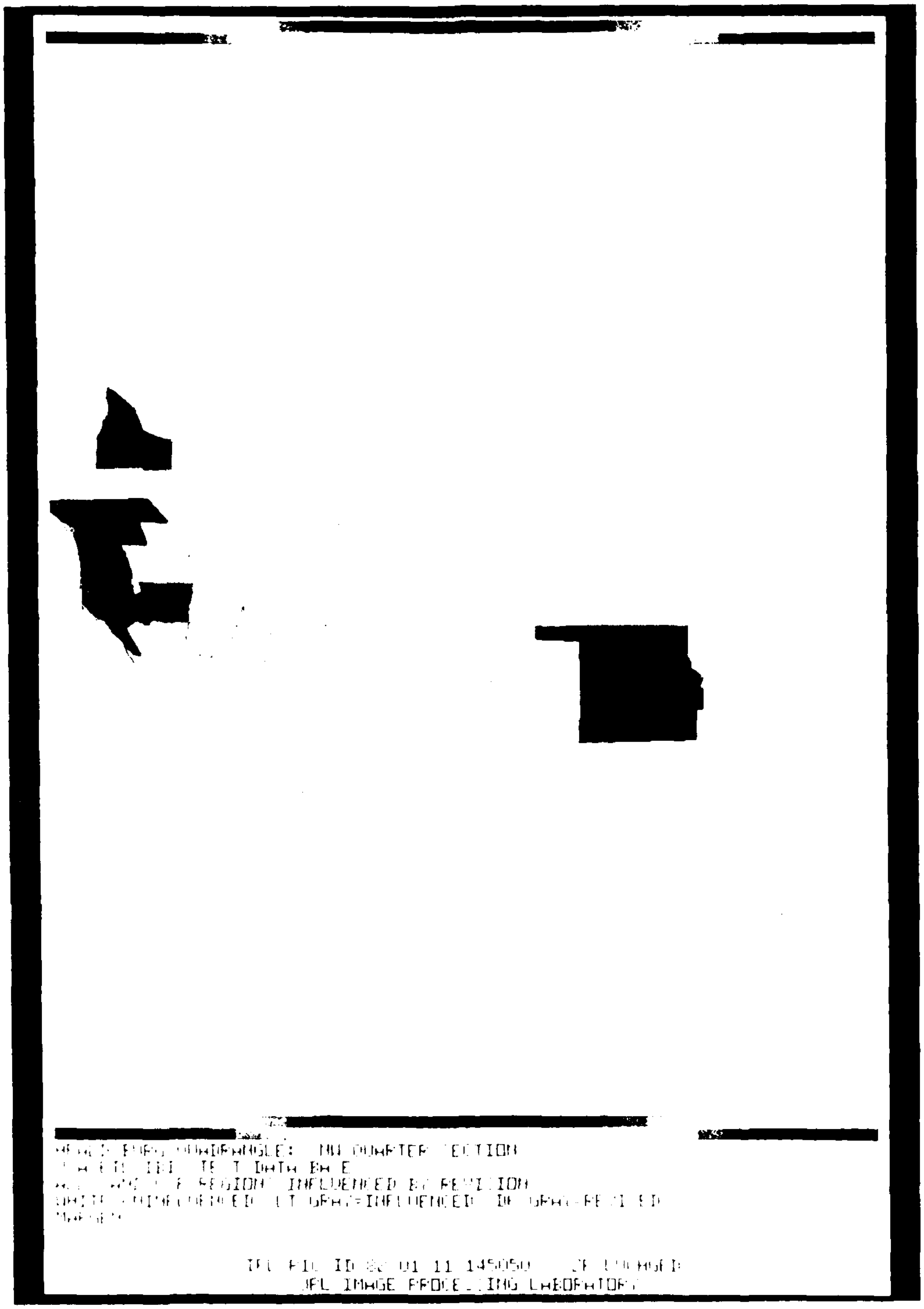


Figure 3-[illegible]. Map [illegible] All Areas within the Floodplain and below [illegible], an Example of a More Complex Query



[illegible] Map Depicting All Land Use Areas Altered by Revision (Altered regions are depicted in two shades of gray. The dark tone denotes those areas actually altered, while the lighter tone denotes the portions of those regions which were unaffected by the revision.)

SECTION 4

CONCLUSIONS

The JPL task, An Image Based Approach to Mapping, Charting, and Geodesy, has been completed on a best efforts basis. Most items outlined in the Objectives section (Section 1.2.1) and the MC&G task work statement prepared by the ETL have been produced. The products and results obtained from this study, though similar to those produced by TASC (Sharpley, 1978) in an earlier study for ETL, reflect the specific features and data processing algorithms which make IBIS a unique GIS. In completing the MC&G task, several improvements and areas for expansion of IBIS capabilities were identified and are covered in the final portion of the section.

4.1 REVIEW OF OBJECTIVES

The five basic objectives outlined in Section 1.2.1 were derived from the work statement prepared by ETL for the JPL MC&G task. The objectives were conceived to demonstrate the capability of IBIS cartographic data in building a data base for MC&G operations. The capability to execute a defined set of areal tabulation and query operations was to be demonstrated as well. Most objectives and data processing operations were completed satisfactorily, though one objective was found to be impossible to complete.

4.1.1 Demonstration of Basic Data Processing Capabilities

One primary objective of the research task was to build an MC&G data base with IBIS. Basic to the objective is the ability to register all input data to a common map base (planimetric base) and the subsequent conversion of the data to image format. This objective was completed successfully. In one case, special rubber sheeting algorithms were utilized to register the land use revision data set to the other three data sets. This demonstrated that spatial alignment and local distortion problems frequently encountered in building a GIS, which can be caused by several factors such as differing map projections, map completion errors, human inferences, and simple errors, can be identified and removed with IBIS.

4.1.2 Demonstration of Capability to Incorporate Image and Non-Image Data

It was hoped that Landsat MSS and DMA digital terrain data could be added to the MC&G data base. However, due to extreme scale differences between the imagery and the data base, the merging operation was not completed since large-scale imagery of the study area was unavailable at JPL. The scale differences were so extreme that if the digitized cartographic data were transformed to the 80-meter resolution of the digital Landsat data, the relationship of the map data to reality would be lost. Similarly if the coarsely resolved Landsat digital imagery was registered to the MC&G data base, so little data would be added to the data base that it would be considered meaningless in subsequent operations.

4.1.3 Demonstration of Ability to Add New Data to the Data Base

Since the IBIS data base consists of several *independent image* planes and tabular files, the system configuration facilitates either adding or *substracting information* from the data base as long as complete image planes are added or deleted in the process. New image files can be added and old files deleted at any time. Image files comprising the data base can be reprocessed or modified and returned to the data base as replacements for old image planes or as new image planes. When compared to topologically structured files, IBIS is not a rigidly structured data base that requires all relationships to be defined at the formation of the data base. IBIS data planes are and can be included in or excluded from data base operations at the discretion of the analyst. When needed for a specific application, selected windows from any of the data planes *can be specified for modification.* Resultant images can be added to the data base as new image planes or as a replacement for existing image planes. In the case of adding land use revision data, the original land use data plane was not modified. Instead, a new data plane depicting land use revisions was produced and incorporated into the data base. This method provides an added feature to the data base, the concept of time. The temporal nature of non-static themes such as land use can be retained for analysis and modeling.

4.1.4 Demonstration of the Capability to Merge Data

The ability to merge data from several adjoining map sheets was demonstrated by the concatenation of the two partially complete land use image planes (top and bottom) into the land use image plane used in the data base construction. No seams or misregistration problems were apparent.

4.1.5 Demonstration of Query Capabilities

One *prime consideration in building the MC&G data base was to ensure* that a procedure which would enable the querying of the constituent thematic elements comprising the data base could be implemented. The queries were performed via a stored macrolanguage procedure with the aid of a mathematical table file generator. By communicating to the master interface file, queries were used to pose specific questions about the study area. Results were printed in tabular form, and thematic maps were also produced.

The query procedure utilized would satisfy all needs for obtaining information from the current MC&G data base. However, *if the size of the data base was expanded to include (1) a larger geographic area, (2) finer spatial resolution, or (3) more data planes, the query procedure might become* ineffective. Proposals for a new query method are covered at the end of this section.

4.2 A COMPARISON BETWEEN JPL AND TASC APPROACHES TO MC&G

Although some deliverable products produced at JPL are similar to those produced by TASC, the data processing approaches embodied by both institutions are quite different. The ramifications of each institution's

philosophy and approach to the processing of spatial data affect the actual time expended in both the building and processing of a data base, as well as the flexibility to solve a variety of complex GIS related problems with the data base.

4.2.1 System Configuration Implications

The most fundamental difference between JPL's and TASC's approach to MC&G operations arises out of differences in the basic components comprising data bases for both systems. ODYSSEY in a topologically structured data base. The most basic element of the data base is the point on a Cartesian plane. Groups of points form line segments, and several line segments are chained to form a polygon. The concept of <u>insideness</u> (i.e., being inside or outside a specific polygon) is not intrinsically known without inspection of polygonal edges, or line segments bordering a polygon. IBIS is a raster-based GIS, the raster image being the basic format for data storage. Though line segment files are processed, they are included in IBIS to provide the mechanism needed to add non-image spatial data to the data base. Where ODYSSEY considers points to be the basic geometric unit, pixels serve the same pupose within IBIS.

Pixels are a unique storage feature. They do not need to have explicit positional referencing as their position is implied by their location in the raster display. With IBIS, a geographic region is defined by all adjacent pixels having the same gray value. This data storage format favors simple histogramming techniques such as image plane overlay or areal calculation and also enables the utilization of the entire VICAR image processing system program library as a supplement to IBIS programs.

4.2.2 Output Products

Both GIS feature tabular line printer and spatial display of data. The types of tabular reports available from both systems are virtually identical, as the same basic types of information can be reported. However, maps derived from data base queries are distinctly different. Since ODYSSEY deals with edges, only the boundaries of geographic features can be shown (Figure 4-1). With complex topology, it becomes hard to determine what is inside and what is outside the polygon(s) mapped. IBIS, on the other hand, is an areal based system, and mapped areas are displayed as regions of uniform gray tone. This feature of IBIS improves the visual discriminability of islands and other complex features. With this display format, edge features can be added to improve spatial referencing. By extending the display to multiple gray tones, complex queries with hierarchical answers can be displayed as well (Figure 4-2).

4.2.3 Comparative Space and Time Expenditures

It is hard to assess the comparative expenditures for MC&G application between the TASC and JPL studies. Both projects involved considerable procedural development; and operational data processing in a production

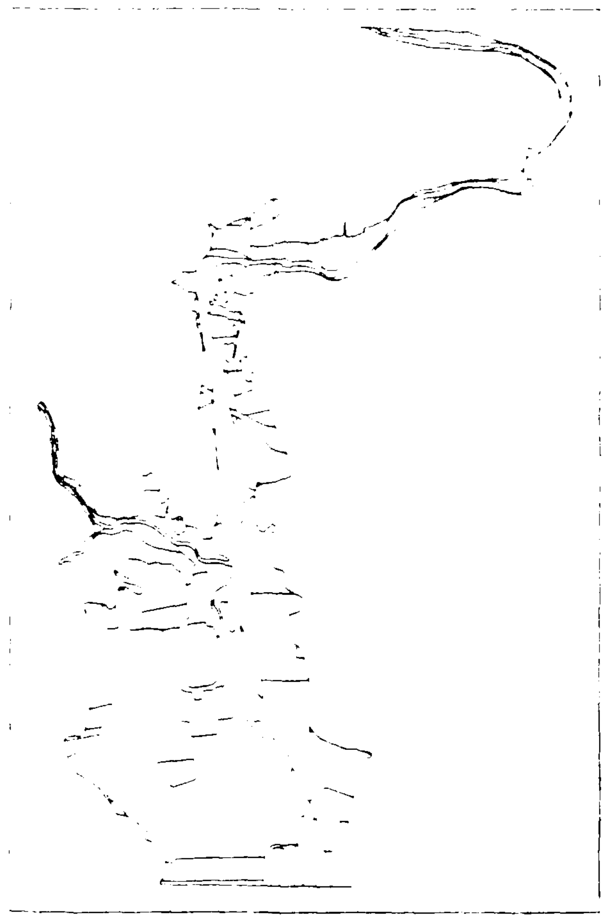


Figure 4-1. Different Approaches to Depicting Results of a Query, ODYSSEY (Left) and IBIS (Right)
(With ODYSSEY, island features may not be readily evident.)

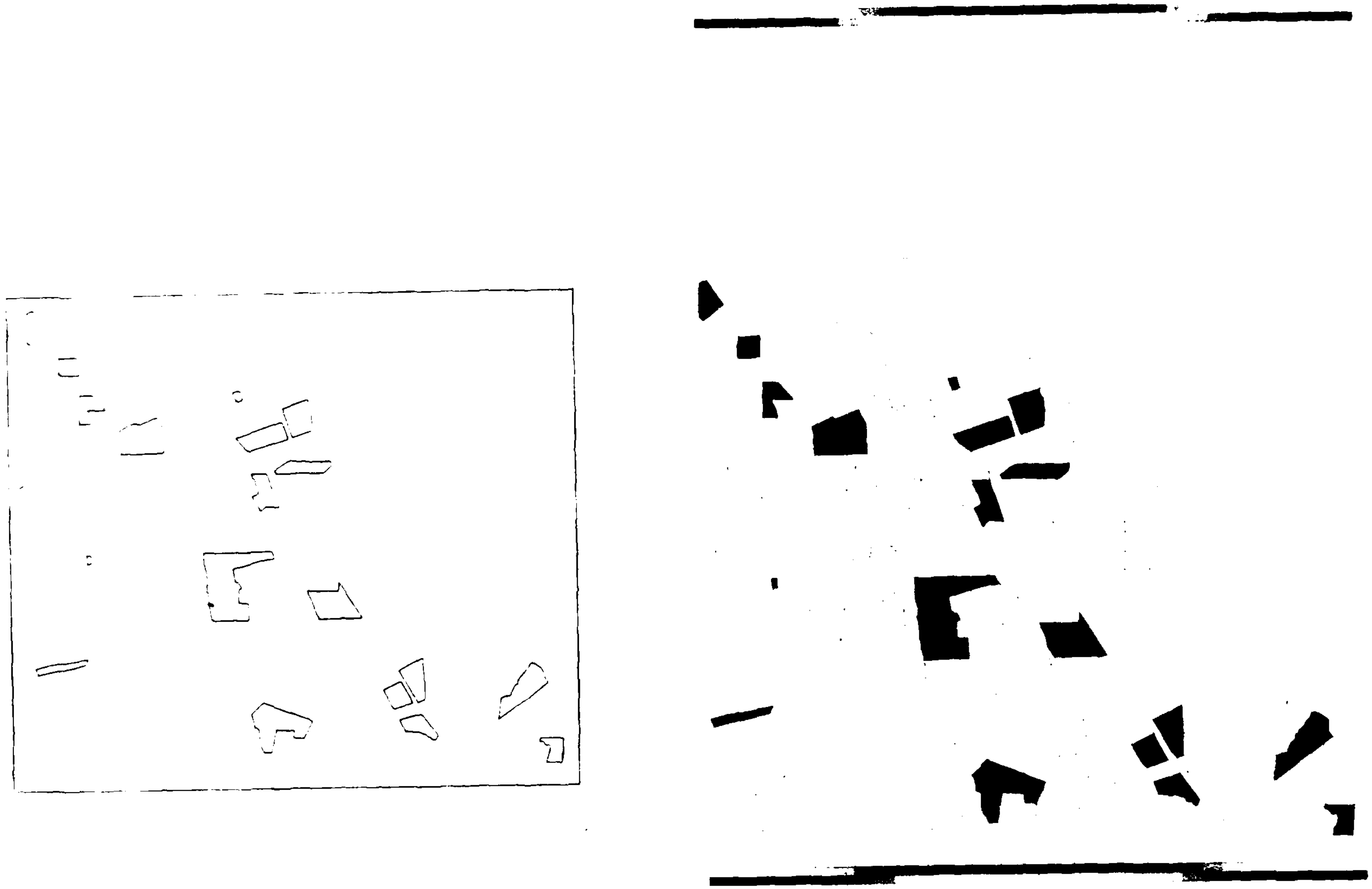


Figure 4-2. Images Showing That a Query Can Be Analyzed in a Spatial Context with IBIS (Gray tones are added to designate areas, and line segments are added to define spatial relationships. The ODYSSEY approach (left) cannot feature the same information as the IBIS approach (right).)

environment would be less expensive for either GIS. Several tables were prepared by TASC to assess the relative requirements and costs of processing data with ODYSSEY. Some of these tables can be modified to compare IBIS to ODYSSEY.

A comparision between the number of geographic regions (IBIS) and polygons (ODYSSEY) comprising each map overlay in both systems (Table 4-1) shows that in most cases the IBIS data set contained more regions than polygons of the same ODYSSEY data set. The difference can be attributed to the different storage schemes for polygonal data with ODYSSEY and geographic regions with IBIS. With ODYSSEY, the topological structure of a polygon remains intact even if line segments converge, or a pinch occurs at one or several places. With IBIS, when line segments defining a geographic region become pinched, two or more independent regions will be formed during the region assignment process.

These extra geographic regions can be dealt with in two ways. With one method, the pinched region can be recorded to ensure that each subregion is assigned the same region identification code. This procedure, however, is a labor-intensive and time-consuming process. The other method is more frequently used. It involves manipulation of the interface file representing the region labeled data plane.

When comparing the number of polygons forming the LCGU data base for ODYSSEY with the number of regions comprising the CF data plane, the IBIS data plane contains significantly less spatial areas. The difference here is that IBIS has a rudimentary sliver removal algorithm included in its region identification process while ODYSSEY does not. A threshold parameter is included in the IBIS painting process that effectively limits the minimum size of polygons to _n_ pixels. Any pixels comprising those small polygons are assigned to adjacent polygons on a random assignment basis.

Table 4-1. Data Base Size Comparisons

Data Set	Number of polygons TASC[a]	JPL
Land use	210	229
Topography	70	77
Floodplain	3	4
Land use revisions	N.A.	5
Combined data sets	958	763

[a] Source: Sharpley, 1978.

Comparing time spent on the computer to build the data base indicates that the JPL and TASC approach require nearly the some amount of computer time in building the data base (Table 4-2). But the JPL approach to polygon overlay is significantly faster, while the TASC query procedure seems faster than JPL's.

This comparison should be made cautiously, for different computers were utilized by TASC and JPL, and the output products derived from the data base queries were quite different. With the TASC approach, simple plots were produced, while the IBIS approach involved more complex image generation procedures.

Table 4-2. Comparison of Processing Timing

Operation -Data set	CPU Timings	
	TASC[a]	JPL[b]
Data set preparation	37 total min	23 total min
-Land Use	15 min	
-Topography	20 min	Average time
-Floodplain	5 min	5.81 min
-L.U. revisions	N.A.	
Image plane (polygon)	7	4.2
Query	12 - 24 sec	2 min avg.

[a] TASC computer was PDP-10. Source: Sharpley, 1978.
[b] JPL computer was IBM 370-158.

4.3 RECOMMENDATIONS FOR IBIS EXPANSION

In completing the MC&G task, it was determined that some IBIS features could be modified to be more useful and effective. Other features which would greatly improve the capability of IBIS in manipulating geographic and other forms of spatial data were identified. Specifically, three research topics might be useful for further investigation.

4.3.1 Advanced Image Query

During the execution of the MC&G project (JPL Task RD-182), data base queries were performed by submitting questions to a special tabular file which was logically linked to a CF data plane, the CF data plane being an image file composed of all unique geographic regions formed by the combination of the four data planes (land use, topography, floodplain, and land use revisions) in the data base. When a query was made, regions fitting the description of the query were flagged and mapped through a process similar to choroplethic mapping.

As demonstrated, the procedure proved to be effective for small data bases the size of Healdsburg. But if the number of data planes comprising the data base and/or the extent of the study area were increased, the number of unique geographic regions produced would preclude the construction of the georeference base and tabular file. Consequently, another method for querying must be formulated. A more sophisticated query based on the analysis of each individual thematic data plane is one approach to this problem. Such a

procedure would involve breaking the query down into questions pertaining to each individual data plane. Then each data plane could be queried individually, producing several binary masks. The logical intersection of these binary-mask data planes would be the answer to the original question. Currently, software does not exist for this procedure, but its benefits would be substantial. The procedure would involve optimal methodology for synthesis of the binary masks to determine areas of logical intersection. As an alternative to the current methodology, this technique would involve direct queries to the image data planes instead of through a tabular file.

4.3.2 Point and Line Overlay

IBIS software exists for overlay of two or more image planes. Results from the process (areal measurements or pixel counts) are stored and can be reported as a regular feature of the information system. This is how acreage tabulations for land use and other thematic features were derived from the data base for JPL Task RD-182. Currently, no effective method has been developed to determine the nature of features within a radius of a given point and/or along a sinuous or linear feature. The possible benefits to be derived from determining what features lie along a given stretch of road-bed for example would be quite useful. The inclusion of a point-and-line overlay procedure in IBIS would greatly enhance the system's utility.

4.3.3 The Sliver or Skinny Region Problem

As several line segment image planes are combined to form a composite feature image, the number of unique geographic regions increases substantially. Several of these polygons are quite small and are actually unimportant in the global sense. Frequently they are a result of distortions caused by map projection and/or slight geometric registration differences. As more vector images are combined, the number of these sliver or skinny regions increases to the point where the data base is overloaded with small pieces of data, and eventually the data base will collapse.

The solution to the problem is to generalize the data base through selection of pertinent detail. This procedure has not been formulated for data processing in the image domain, and should be considered to be one of the more challenging problems currently facing users of automated geographic information systems.

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APPENDIX A

A.0 THE IMAGE-BASED INFORMATION SYSTEM: AN OVERVIEW

The Image-Based Information System (IBIS) is a computer-based approach to spatial analysis. It is a versatile geographic information system enabling the analysis and investigation of a variety of phenomena in a geographic context. IBIS (Bryant and Zobrist, 1977; Zobrist, et al., 1979) is considered to be a raster-based information system, as the primary mode for data storage is the raster, or digital image. However, the system is configured in such a manner that other data types, such as vector and tabular data, may be used in analysis as well.

Logical and mathematical interfaces have been provided to link the various types of data files that can comprise an IBIS data base. (Figure A-1). By utilizing these interfaces, information may be derived from simple associations of, or comparisons between, two or more data files stored in an IBIS data base. More complex procedures including image plane (polygon) overlay and cross-tabulation can also be investigated.

A.1 DATA MANAGEMENT CONSIDERATIONS

The raster-formatted data plane is the primary data type utilized in IBIS processing. IBIS data planes may be obtained directly in image form, such as Landsat imagery, or they may be derived from vector data compiled by sources such as the U.S. Geological Survey, the U.S. Bureau of the Census, and the Defense Mapping Agency. Regardless of data type and origin, all data planes are incorporated into a data set that is referred to as the IBIS data base (Figure A-2). An IBIS data base will usually consist of several image planes which are stacked, or superimposed, upon each other. When investigating a specific problem, any data plane may be included in, excluded from, or modified before any IBIS processing steps.

A.1.1 The Georeference Base

Provisions have been made to preserve map accuracy standards and provide georeferencing capabilities within IBIS through the development and use of a Georeference Base. The georeference base can be constructed from any map or controlled surface known to be of good planimetric qualities. The referencing system can be in Earth-based coordinates (e.g., latitude, longitude), map-projected coordinates (e.g., meters northing and easting), image-based coordinates (e.g., line, sample), or a combination of these reference systems. The georeference base can be in the form of a digital image such as a scanned topographic map, a constructed table of values which is stored as a special attribute file, or it can be in a combined format. Various types of algorithms have been developed to spatially transform both vector and image data to the projected coordinate system of the georeference base.

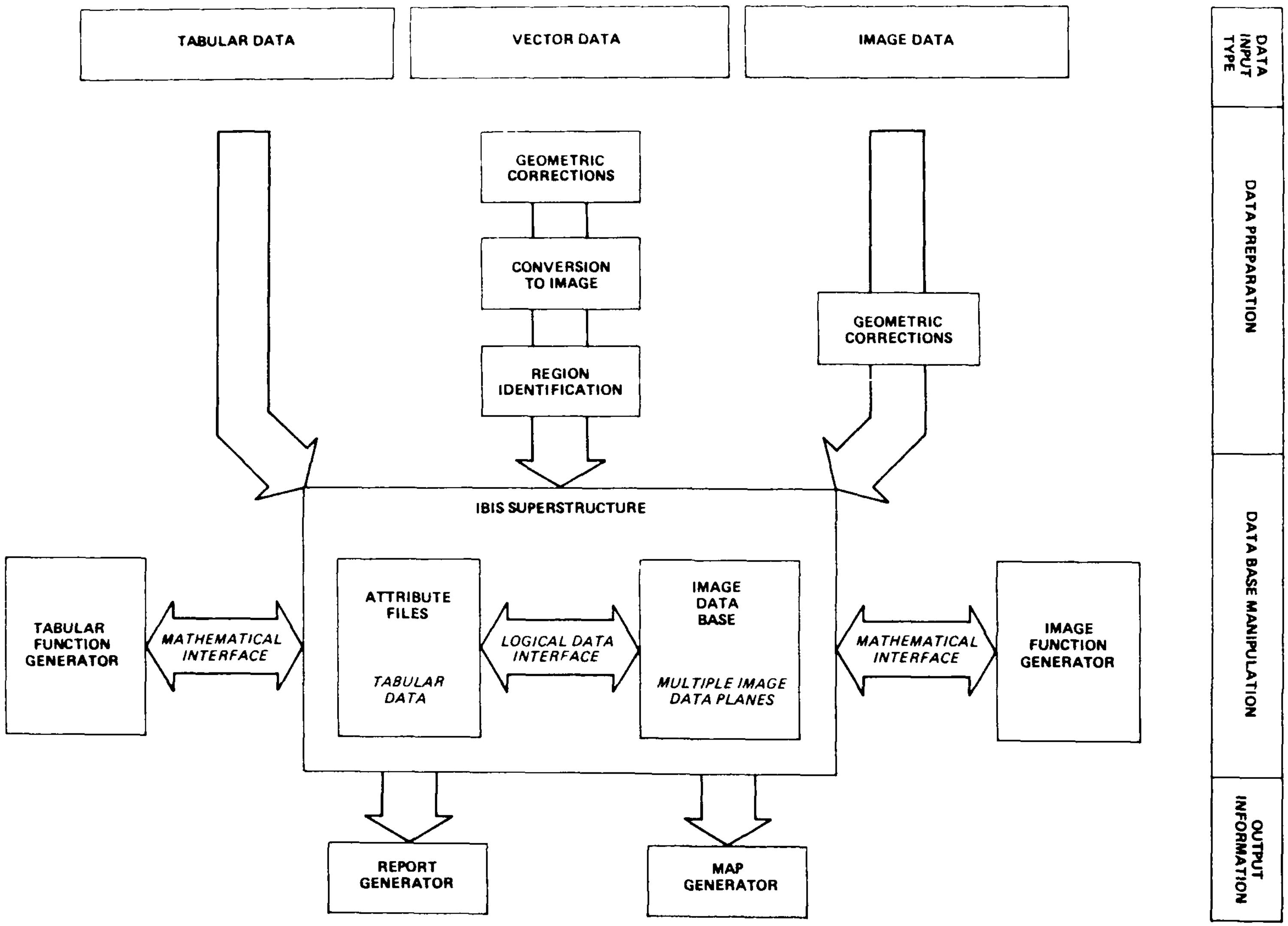

Figure A-1. Configuration Diagram of the Image-Based Information System

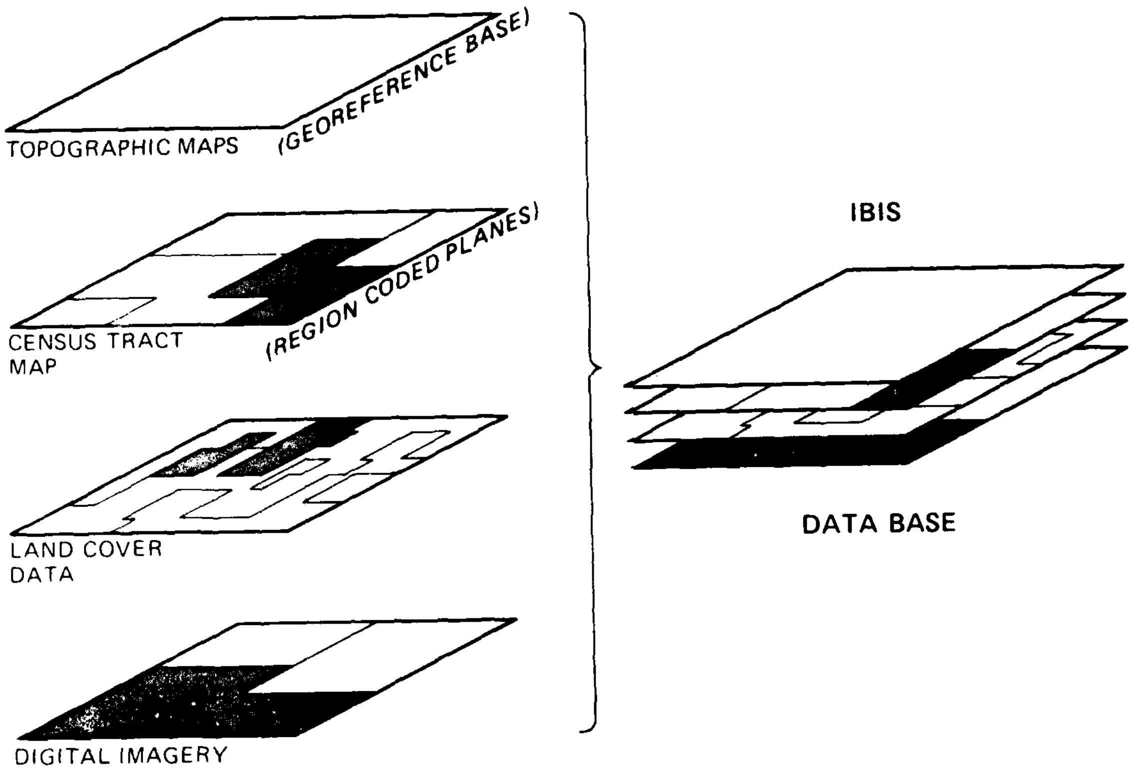

Figure A-2. Formation of an IBIS Data Base

A.1.2 Spatial Rectification

When building a multilayered data base for geographic analysis, spatial continuity between all layers of the data base must be maintained. It is important that the same coordinate position on any and all data planes describe the same identical location in reality. To ensure this situation, all data planes in an IBIS data base are registered to a georeference base known to have good planimetric quality and spatial continuity. Topographic maps are excellent planimetric bases, having been constructed from precise point datum and calibration. When entering thematic material as data planes into the data base, they are geometrically registered to be in precise registration with the georeference base.

Two types of spatial transformation procedures, affine and geometric, are utilized to ensure spatial integrity of the data base. The affine transformation is a simple transformation and can be used to compensate for global deformational characteristics (scale, offset, and rotation). The geometric transformation is a more complex procedure, and it enables the removal of more localized registration anomalies frequently caused by differing map projections, sensor and system instabilities, and human error. The two types of transformations are frequently processed in sequence. The affine transformation is implemented first, moving all data into the same relative image reference space of the planimetric base. Geometric transformation is conditionally evoked if it is found that one or more of the data planes are not in exact registry with the georeference base.

Both types of transformations are controlled by tiepoints which define the deformational characteristics for registering the thematic data to the georeference base. Three tiepoints are required for the affine transformation, while up to several hundred tiepoints may be required to define irregular deformations with the geometric procedure.

The selection of tiepoints for affine or geometric transformations is frequently an iterative process. Successive refinements in tiepoint positioning may be required to achieve the desired results.

These transformations may be performed on data in image or vector format. For coordinate digitized map data, the transformations are usually performed while the data are in vector format. Vector data are then converted into images. This done to reduce computer processing costs and to maintain better spatial alignment and formation of the line segments. Geometric transformations of line segments and other narrow features in image space have frequently caused disruption in connectivity and fuzzing of line edges. Performing the transformations on data in vector space eliminates this problem.

A.1.3 Modes of Data Input

The user of IBIS can integrate various data types to form an IBIS data base. Since the primary data structure is a raster format, image data planes are directly entered into the system. Graphical forms of data, usually obtained in Cartesian reference form, must be transformed into image space prior to inclusion in a data plane. Tabular data are not transformed into

image space but are linked to the image data base through a logical interface. Data processing requirements for each data type are unique and will be covered individually.

A.1.3.1 Image Data. Most image data sets entered into the data base are derived from Landsat imagery or other multispectral scanner sources. Other data are digitally encoded by microdensitometer or from aerial photographs. Since image data are frequently obtained from many sources, the spatial alignment of features contained in those images are often inconsistent from image to image. The spatial alignment procedures described previously can be implemented to obtain a unified spatial surface. Once converted to image space, the files are referred to as data planes or raster image files.

A.1.3.2 Vector Data. Vector or graphical data may also be entered into the IBIS data base. Vector data may be created locally with an electronic coordinate digitizer, or they may be obtained from data tape. The Bureau of Census Urban Atlas and dual independent image encoded (DIME) files are examples of data obtained on computer tapes. Regardless of data origin, vector data are transformed into image space prior to inclusion in the IBIS data base. When vector data are in Cartesian format, they are referred to as vector-graphics files. Once converted to image format, they are referred to as raster-graphics files.

As with image data, vector files must be in registry with the planimetric data base. Provisions have been made within IBIS to achieve the proper spatial alignment. (These corrections are made before the data are transformed into image space.) The deformation from the original surface to the georeference base is controlled by the selection of tiepoints linking geographical features that are identifiable on both the vector data file and the planimetric data base. When three-dimensional or z-value data (x, y, z) are processed, the Cartesian reference components of the data (x, y) are transformed into image space coordinate values, while the z-value remains unchanged.

A.1.3.3 Tabular Data. Tabular data may be entered into IBIS via parameter strings or digital tape. These data are stored in a tabular file that is linked to the data base through a logical interface. These files are used to store thematic material such as population counts, areal measurements, or place names. These tabular files are referred to as attribute files.

A.1.4 The Raster-Region File

One of the more important types of vector data files entered into an IBIS data base are the raster-region files. Raster-region files are used to represent feature space exhibiting distinct regional morphology such as political administrative districts, land use zones, topographic regions, or other thematic features. In many applications, the region file has been constructed from census tract data obtained from the Urban Atlas files of the

U.S. Bureau of the Census. However, raster region image planes can be derived from a variety of cartographic source materials or from purely artificial networks such as a grid.

Within the context of a raster region file, a region is defined as any spatially contiguous feature bounded on all sides by line segments and, optionally, the edge of image space. Regions are identified through the assignment of a unique numerical lable (pixel value to each individual region (Figure A-3). The labeling process is termed painting, and enables the identification of up to 32,767 unique geographic regions from any raster graphics image plane. After region identification process, the raster-region file may be used in several higher-order IBIS procedures. For example, image plane overlay of a raster-region file and some other image data plane can be completed. Alternately, the gray values of each polygon in the georeference base may be modified to produce a map depicting the results of a modeling application with data stored in an interface file.

Several raster-region image planes may be included in an IBIS data base. For example, a data base may contain both a census tract raster-region file and a congressional district region file. The maximum number of regions that can be included in one georeference plane is virtually unlimited.

A.1.5 The Data Interface and Tabular Files

All tabular files (interface files) are linked to at least one raster-region file included in an IBIS data base. The specific link is obtained by storing the numerical value (gray tone) representing each region of the georeference plane with tabular data describing attributes of that region (see Figure A-3). Attribute data may be statistical in origin, an identification code, or the result of an image plane comparison operation such as image plane overlay or cross-tabulation.

A.2 MANIPULATING DATA AND OUTPUT PRODUCTS

If IBIS, or any other information system, were only a device to collect and store geographic data, the utility of the system would be quite limited. Most users of an information system require far more powerful features. Several methods for data output, both pictorial and tabular, are needed. Also, the researcher may want to undertake complex modeling applications with the data files stored in the information system infrastructure. Procedures for data output and data manipulation have been developed as part of the Image Based Information System. Maps may be generated and tabular reports can be obtained.

A.2.1 Data Manipulation Procedures

Data stored in either the data base or an interface file can be modified or manipulated with IBIS software. New data planes and interface files are easily generated. Four basic data manipulation procedures are currently available.

ATTRIBUTE FILE

DATA/ DISTRICT NAME	No. OF IMAGE ELEMENTS	REGION IDENTIFICATION CODE
9.0	1121	13
10.1	3777	22
10.2	5988	23
11.0	776	47
12.0	4232	15

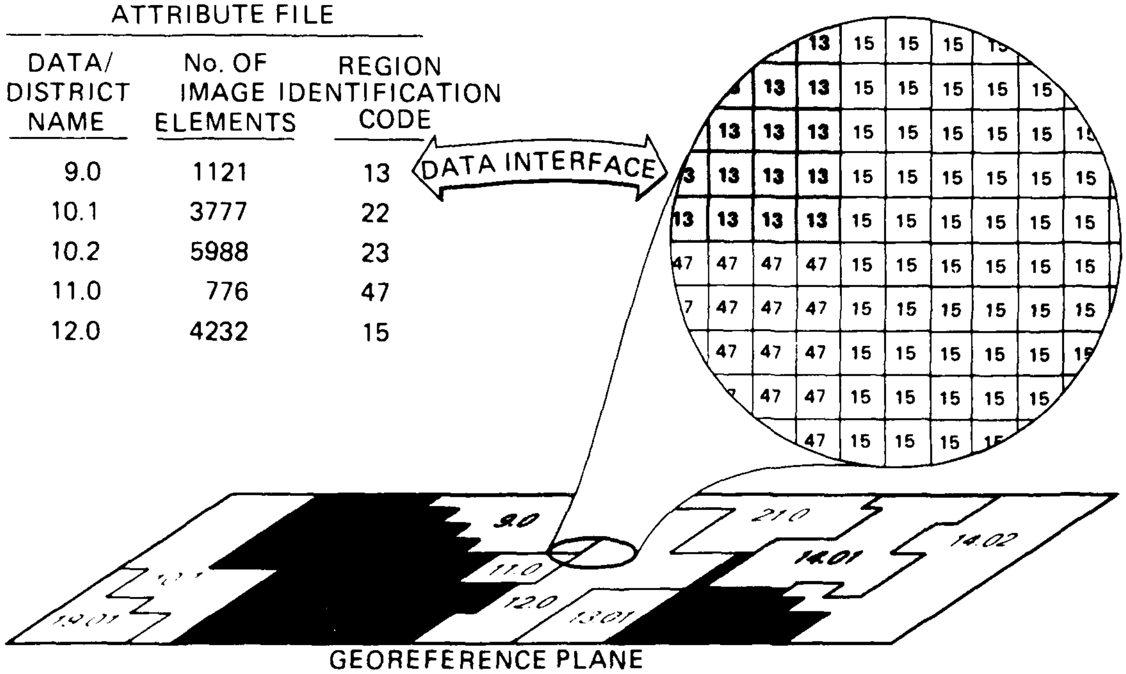

Figure A-3. Data Interface Linking the Tabular Attribute File to a Region-Coded File

A.2.1.1 <u>Data Manipulation Between Image Planes</u>. New image data planes are generated as a function of two or more image data planes. Chiefly, the procedures implemented to derive such data planes are VICAR routines, although some IBIS routines are also used. Simple transformations such as image addition, subtraction, multiplication, and division are easily obtained. Complex functions are handled nearly as easily, and precise mathematical formulas may be specified. Image enhancement routines are available, as are several data classification and stratification routines.

A.2.1.2 <u>Data Manipulation Within the Interface File</u>. Most functions available in the image domain are also available for analysis of tabular data. Resultant from such operations, new tabular data entries are generated. Complex mathematical functions may be used to derive higher-order properties of data stored in an interface file.

A.2.1.3 <u>Data Manipulation of Image Data into Tabular Data</u>. By implementing certain IBIS routines, data originally stored in image format may be summarized and copied into a tabular file. The majority of these routines are aggregation functions, an example of which is image plane overlay.

A.2.1.4 <u>Data Manipulation of Tabular Data into Data Planes</u>. The representation of tabular data in image form is primarily used as an output aid. By the implementation of a map generating routine, any raster-region file can be modified as a function of an interface file. Modeling of data is performed similarly, and queries of the data base are simply composed. Data planes produced in this manner can be entered into the IBIS data base for subsequent operations.

A.2.2 Data Output Features

Two output formats are available to the system user: (1) maps and (2) tabular reports. Maps are produced directly from any image data plane or through modification of georeference planes. Tabular reports are made available through the operation of a report generator.

A.3 SUMMARY

With a knowledge of image processing, an analyst can learn to operate the IBIS system. A researcher can utilize the system to store several data planes and much tabular data. With all of the information at the data user's disposal, many complex modeling problems may be solved relatively effortlessly.

The various modes of data entry, data manipulation, and data output provide the researcher with complete flexibility to structure a unique data base specifically designed for a particular problem or investigation. IBIS is merely a framework for analysis of spatial data. The actual information system is constructed with the selection of specific image and tabular data.

APPENDIX B

DETAILED DATA PLANE DESCRIPTIONS

Table B-1. Numerical Keys Assigned to Land Use and Land Use Revision Codes

Numerical Key	Label Code
1	ACC
2	ACP
3	AR
4	AVF
5	AVV
6	BBR
7	BEQ
8	BES
9	BT
10	FO
11	LR
12	R
13	UCB
14	UCC
15	UCR
16	UCW
17	UES
18	UIL
19	UIS
20	UIW
21	UOC
22	UOG
23	UOO
24	UOP
25	UOV
26	URH
27	URS
28	UUS
29	UUT
30	VV
31	WO
32	WS
33	WWP

Table B-2. Numerical Keys Assigned to 100-Foot Contour Elevation Zones

Numerical Key	Contour Zone (min - max)
0	0 - 100
1	101 - 200
2	201 - 300
3	301 - 400
4	401 - 500
5	501 - 600
6	601 - 700
7	701 - 800
8	801 - 900
9	901 - 1000
10	1001 - 1100

Table B-3. Numerical Keys Assigned to Floodplain Zones

Numerical Key	Floodplain Zone
0	Below
1	Above

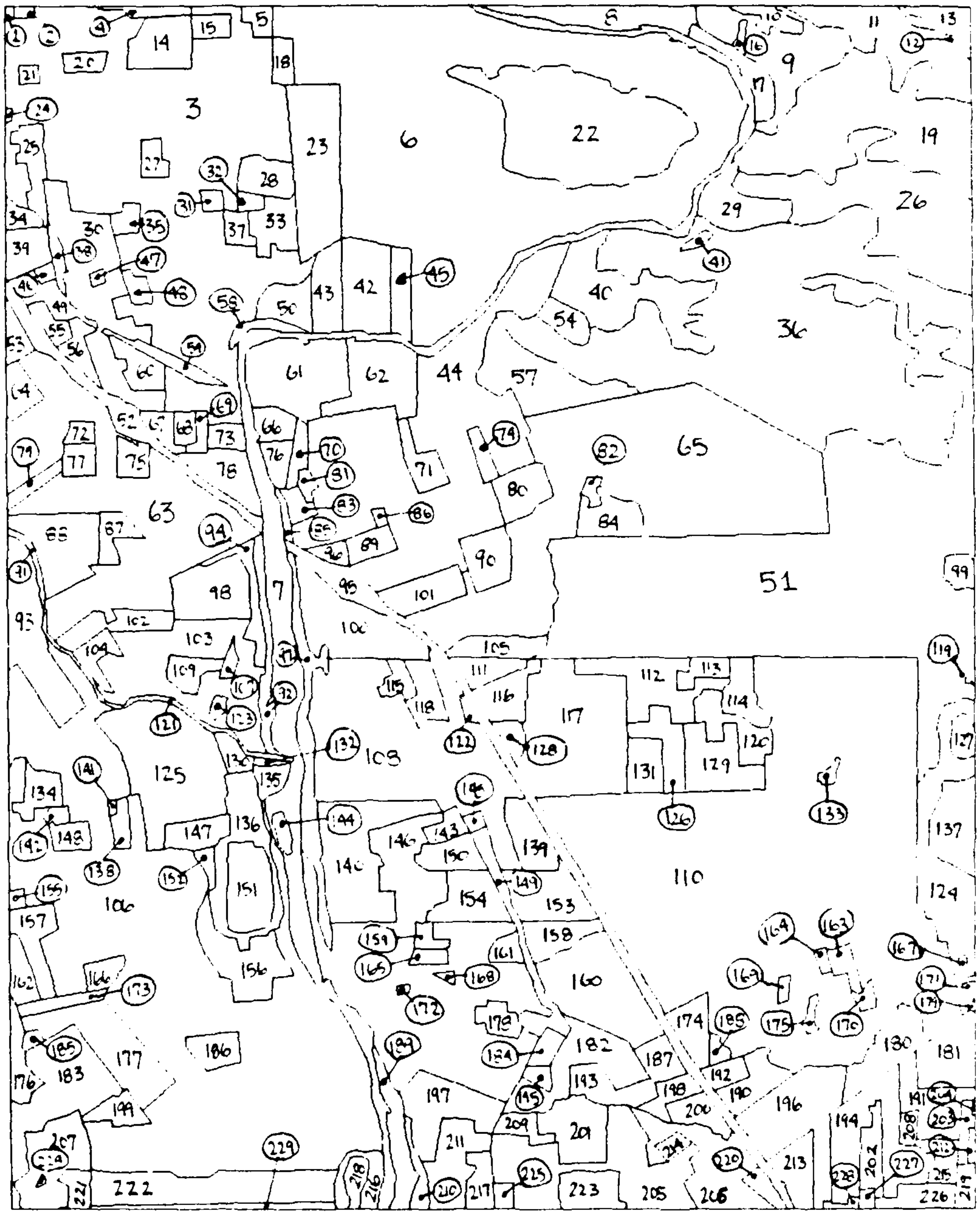

Figure B-1. Numerical Identification Codes Assigned to Geographic Regions Comprising the Land Use Data Plane

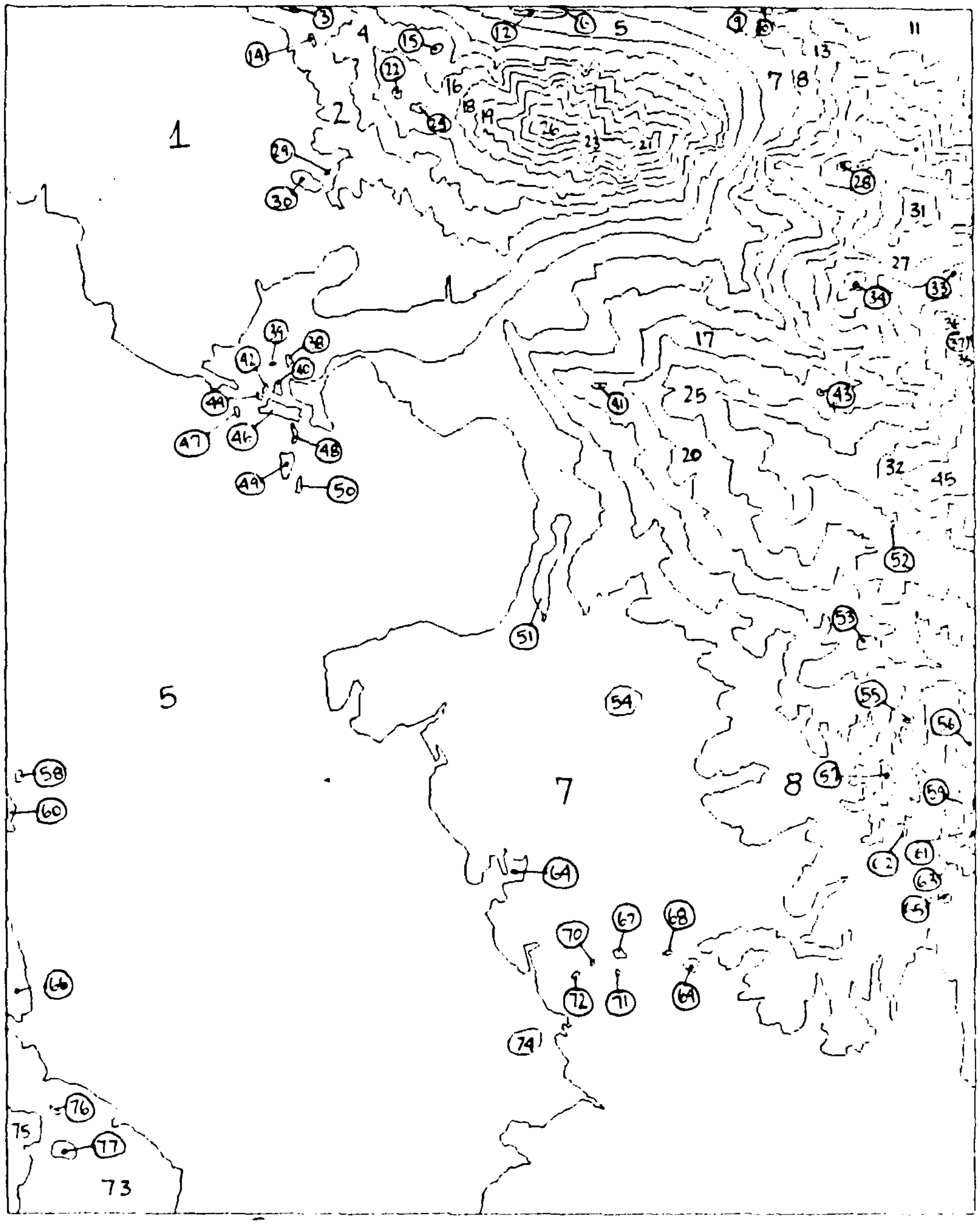

Figure B-2. Numerical Identification Codes Assigned to Regions Comprising the Contour Data Plane

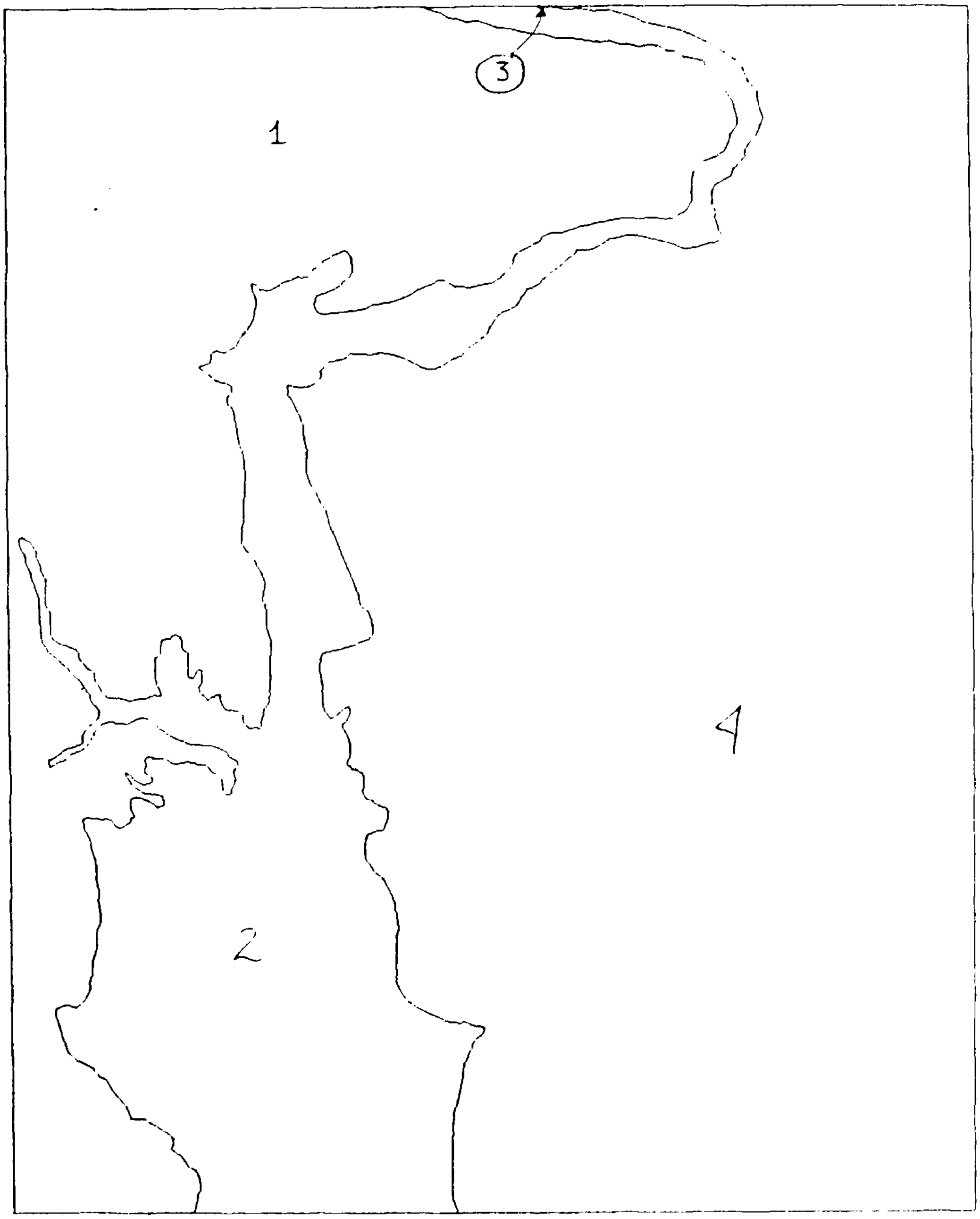

Figure B-3. Numerical Identification Codes Assigned to Regions Comprising the Floodplain Data Plane

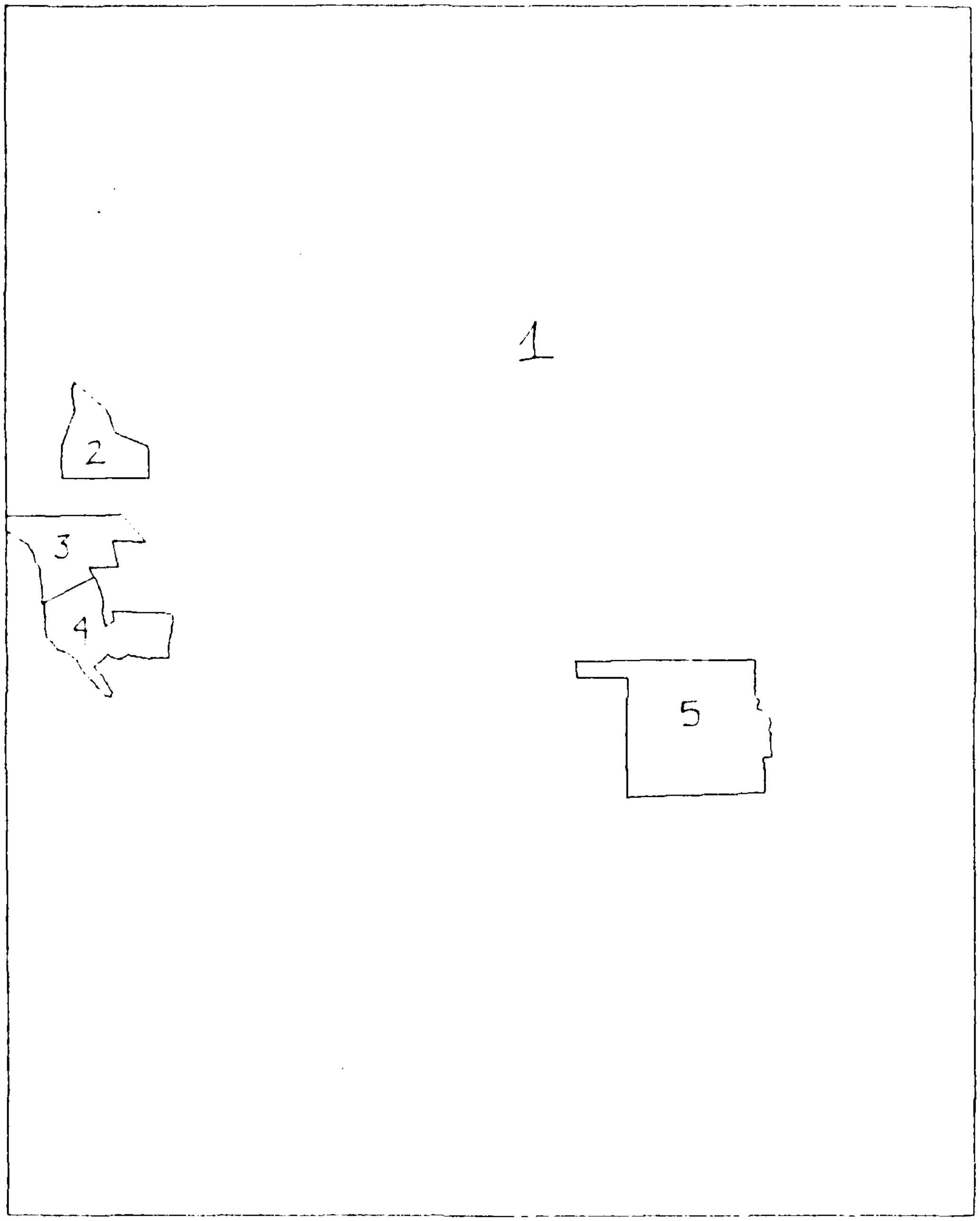

Figure B-4. Numerical Identification Codes Assigned to Regions Comprising the Land Use Revision Data Plane

Table B-4. Healdsburg Quadrangle Land Use Data Plane (1 of 6)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
1	UIS	109	1.00	0.00156
2	UCR	209	1.92	0.00300
3	URS	55730	511.75	0.79961
4	BT	700	6.43	0.01004
5	UCV	703	6.46	0.01009
6	URS	64012	587.80	0.91844
7	WS	19689	180.80	0.28250
8	FO	3399	31.21	0.04877
9	R	6191	56.85	0.08883
10	AVV	952	8.74	0.01366
11	AVF	6659	61.15	0.09554
12	WS	443	4.07	0.00636
13	AVF	1302	11.96	0.01868
14	UCC	2667	24.49	0.03827
15	UCB	799	7.34	0.01146
16	AVV	233	2.14	0.00334
17	URS	1800	16.53	0.02583
18	UCV	839	7.70	0.01204
19	FO	16436	150.93	0.23582
20	AVF	719	6.60	0.01032
21	UCR	317	2.91	0.00455
22	FO	16122	148.04	0.23132
23	UCG	6911	63.46	0.09916
24	UIS	82	0.75	0.00118
25	UIS	1759	16.15	0.02524
26	R	13821	126.91	0.19830
27	UCC	776	7.13	0.01113
28	UCC	1759	16.15	0.02524
29	URS	2934	26.94	0.04210
30	UCR	8351	76.68	0.11982
31	UCC	404	3.71	0.00580
32	AVV	413	3.79	0.00593
33	AVF	1984	18.22	0.02847
34	AVV	684	6.28	0.00981
35	UCC	659	6.05	0.00946
36	FO	52040	477.87	0.74667
37	UCC	784	7.20	0.01125
38	UCW	551	5.06	0.00791
39	UCO	1688	15.50	0.02422
40	R	7188	66.01	0.10313
41	AVF	257	2.36	0.00369
42	AVF	3864	35.48	0.05544

Table B-4. Healdsburg Quadrangle Land Use Data Plane (2 of 6)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
43	AVV	2215	20.34	0.03176
44	AVF	30287	278.12	0.43456
45	BT	1561	14.33	0.02240
46	UCW	260	2.39	0.00373
47	UCP	171	1.57	0.00245
48	UCB	594	5.45	0.00852
49	URS	1496	13.74	0.02146
50	AVF	1796	16.49	0.02577
51	R	63522	583.30	0.91141
52	UUT	3773	34.65	0.05413
53	URS	921	8.46	0.01321
54	AR	1273	11.69	0.01826
55	AVF	811	7.45	0.01164
56	UCW	1066	9.79	0.01529
57	R	5509	50.59	0.07904
58	LF	660	6.06	0.00947
59	UUT	1066	9.79	0.01529
60	UIL	1465	13.45	0.02102
61	UES	6026	55.33	0.08646
62	URC	4472	41.07	0.06416
63	AVF	23564	216.38	0.33810
64	ACC	1222	11.22	0.01753
65	ACF	37091	340.60	0.53218
66	UCP	1124	10.32	0.01613
67	UCC	864	7.93	0.01240
68	UCR	621	5.70	0.00891
69	UIS	502	4.61	0.00720
70	UIS	784	7.20	0.01125
71	AVV	1460	13.41	0.02095
72	AVV	526	4.83	0.00755
73	URH	821	7.54	0.01178
74	AVV	703	6.46	0.01009
75	UIS	1006	9.24	0.01443
76	URS	975	8.95	0.01399
77	ACC	940	8.63	0.01349
78	URS	2428	22.30	0.03484
79	AVV	704	6.46	0.01010
80	AVV	2055	18.87	0.02949
81	URS	373	3.43	0.00535
82	UIW	348	3.20	0.00499
83	VV	679	6.24	0.00974
84	AVV	2079	19.09	0.02983

Table B-4. Healdsburg Quadrangle Land Use Data Plane (3 of 6)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
85	LF	333	3.06	0.00478
86	ACC	197	1.81	0.00283
87	ACC	1188	10.91	0.01705
88	AVV	4334	39.80	0.06218
89	UIL	1112	10.21	0.01595
90	ACC	2144	19.69	0.03076
91	WS	817	7.50	0.01172
92	LF	1767	16.23	0.02535
93	AVF	5465	50.18	0.07841
94	UFS	1468	13.48	0.02106
95	UUT	7520	69.05	0.10790
96	UCC	575	5.28	0.00825
97	LF	4077	37.44	0.05850
98	ACC	3687	33.86	0.05290
99	AF	840	7.71	0.01205
100	AVF	5777	53.05	0.08289
101	ACC	2190	20.11	0.03142
102	AVV	2048	18.81	0.02938
103	AVF	9887	90.79	0.14186
104	ACP	1126	10.34	0.01616
105	ACC	1689	15.51	0.02423
106	AVV	69718	640.20	1.00031
107	AVV	350	3.21	0.00502
108	AVV	20096	184.54	0.28834
109	URS	1200	11.02	0.01722
110	ACP	85992	789.64	1.23381
111	AVV	1282	11.77	0.01839
112	AVF	4306	39.56	0.06181
113	AVV	954	8.76	0.01369
114	ACP	1712	15.72	0.02456
115	UIW	829	7.61	0.01189
116	AVF	1965	18.04	0.02819
117	AVV	11109	102.01	0.15939
118	ACC	1565	14.37	0.02245
119	WWP	25	0.23	0.00036
120	AVV	2266	20.81	0.03251
121	WS	830	7.62	0.01191
122	AVF	180	1.65	0.00258
123	AVV	259	2.38	0.00372
124	ST	7319	67.21	0.10501
125	AVF	10037	92.17	0.14401
126	AVV	2100	19.28	0.03013

Table B-4. Healdsburg Quadrangle Land Use Data Plane (4 of 6)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IRIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
127	R	823	7.56	0.01181
128	URS	708	6.50	0.01016
129	ACP	3443	31.62	0.04940
130	AVV	815	7.48	0.01169
131	URS	1687	15.49	0.02421
132	BBR	183	1.68	0.00263
133	WWP	270	2.48	0.00387
134	AVF	1437	13.20	0.02062
135	AVV	918	8.43	0.01317
136	URS	4191	38.48	0.06013
137	R	3138	28.82	0.04502
138	AVF	691	6.35	0.00991
139	ACP	2187	20.08	0.03138
140	ACC	7185	65.98	0.10309
141	ACC	100	0.92	0.00143
142	UPS	337	3.09	0.00484
143	AR	806	7.40	0.01156
144	BBR	473	4.34	0.00679
145	UPH	283	2.60	0.00406
146	AVV	27535	252.85	0.39507
147	UUS	1537	14.11	0.02205
148	AVF	930	8.54	0.01334
149	URS	2396	22.00	0.03438
150	UIS	1625	14.92	0.02332
151	WO	3269	30.02	0.04690
152	AVF	459	4.21	0.00659
153	ACC	3327	30.55	0.04774
154	AR	2681	24.62	0.03847
155	AVF	276	2.53	0.00396
156	AVF	3931	36.10	0.05640
157	ACP	2132	19.58	0.03059
158	AVV	1853	17.02	0.02659
159	ACP	555	5.10	0.00796
160	URS	6963	63.94	0.09990
161	URS	693	6.36	0.00994
162	URS	1242	11.40	0.01782
163	AVV	761	6.99	0.01092
164	AVF	254	2.33	0.00364
165	AVF	480	4.41	0.00689
166	ACP	852	7.82	0.01222
167	WWP	172	1.58	0.00247
168	FO	135	1.24	0.00194

Table B-4. Healdsburg Quadrangle Land Use Data Plane (5 of 6)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IRIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
169	AVF	243	2.23	0.00349
170	WWP	377	3.46	0.00541
171	P	164	1.51	0.00235
172	UUS	91	0.84	0.00131
173	ACC	909	8.35	0.01304
174	ACC	1733	15.91	0.02487
175	WWP	321	2.95	0.00461
176	ACP	1496	13.74	0.02146
177	AVF	5220	47.93	0.07490
178	UCC	1027	9.43	0.01474
179	P	54	0.50	0.00077
180	ACC	2953	27.12	0.04237
181	BT	3055	28.05	0.04383
182	AVF	4630	42.52	0.06643
183	AVV	6559	60.23	0.09411
184	AVV	732	6.72	0.01050
185	UFS	265	2.43	0.00380
186	AVF	1371	12.59	0.01967
187	ACC	1308	12.01	0.01877
188	AVV	419	3.85	0.00601
189	BBF	2295	21.07	0.03293
190	AVV	1967	18.06	0.02822
191	ACP	2974	27.31	0.04267
192	AVF	855	7.85	0.01227
193	AVV	1977	18.15	0.02837
194	ACP	6018	55.26	0.08635
195	UFS	448	4.11	0.00643
196	AVF	6268	57.56	0.08993
197	ACC	4193	38.50	0.06016
198	UFS	1147	10.53	0.01646
199	UFS	1208	11.09	0.01733
200	ACC	1357	12.46	0.01947
201	UFS	3186	29.26	0.04571
202	AVV	1468	13.48	0.02106
203	AVF	618	5.67	0.00887
204	AVV	39	0.36	0.00056
205	ACP	8996	82.61	0.12907
206	UFS	5207	47.81	0.07471
207	ACP	4135	37.97	0.05933
208	AVV	509	4.67	0.00730
209	AVV	1000	9.18	0.01435
210	LP	827	7.59	0.01187

Table B-4. Healdsburg Quadrangle Land Use Data Plane (6 of 6)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
211	AVV	3263	29.96	0.04682
212	AVV	230	2.11	0.00330
213	ACP	1955	17.95	0.02805
214	UIS	472	4.33	0.00677
215	ACC	1143	10.50	0.01640
216	BEQ	1441	13.23	0.02068
217	AR	1256	11.53	0.01802
218	WO	798	7.33	0.01145
219	ACP	782	7.18	0.01122
220	BT	671	6.16	0.00963
221	AVV	888	8.15	0.01274
222	AVF	6782	62.28	0.09731
223	AVV	2025	18.59	0.02905
224	WWP	54	0.50	0.00077
225	AVV	454	4.17	0.00651
226	URS	1501	13.78	0.02154
227	AVV	278	2.55	0.00399
228	URS	256	2.35	0.00367
229	AVV	1310	12.03	0.01880

Table B-5. Healdsburg Quadrangle Contour Data Plane (1 of 2)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
CONTOUR DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
1	150	101144	928.77	1.45120
2	250	21204	194.71	0.30423
3	350	64	0.59	0.00092
4	350	14100	129.48	0.20231
5	50	361599	3320.43	5.18811
6	150	19	0.17	0.00027
7	150	212938	1955.33	3.05516
8	250	77971	715.98	1.11872
9	350	8	0.07	0.00011
10	350	124	1.14	0.00178
11	150	5778	53.06	0.08290
12	150	271	2.49	0.00389
13	350	38578	354.25	0.55352
14	350	50	0.46	0.00072
15	450	74	0.68	0.00106
16	450	10431	95.78	0.14966
17	450	29276	268.83	0.42005
18	550	4944	45.40	0.07094
19	650	4325	39.72	0.06205
20	550	28852	264.94	0.41397
21	750	2895	26.58	0.04154
22	350	70	0.64	0.00100
23	850	1864	17.12	0.02674
24	550	103	0.95	0.00148
25	650	28716	263.69	0.41202
26	950	691	6.35	0.00991
27	750	20577	188.95	0.29524
28	750	91	0.84	0.00131
29	250	17	0.16	0.00024
30	250	356	3.27	0.00511
31	850	1277	11.73	0.01832
32	850	8268	75.92	0.11863
33	950	209	1.92	0.00300
34	850	392	3.60	0.00562
35	950	2076	19.06	0.02979
36	1050	375	3.44	0.00538
37	350	20	0.18	0.00029
38	150	46	0.42	0.00066
39	150	12	0.11	0.00017
40	150	71	0.65	0.00102
41	550	55	0.51	0.00079
42	150	21	0.19	0.00030

Table B-5. Healdsburg Quadrangle Contour Data Plane (2 of 2)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
CONTOUR DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
43	650	28	0.26	0.00040
44	150	21	0.19	0.00030
45	950	2693	24.73	0.03864
46	150	397	3.65	0.00570
47	150	35	0.32	0.00050
48	150	53	0.49	0.00076
49	150	231	2.12	0.00331
50	150	48	0.44	0.00069
51	250	1166	10.71	0.01673
52	750	9	0.08	0.00013
53	550	169	1.55	0.00242
54	250	675	6.20	0.00968
55	550	28	0.26	0.00040
56	450	13	0.12	0.00019
57	450	428	3.93	0.00614
58	150	63	0.58	0.00090
59	350	1593	14.63	0.02286
60	150	225	2.07	0.00323
61	450	568	5.22	0.00815
62	350	33	0.30	0.00047
63	550	12	0.11	0.00017
64	150	15	0.14	0.00022
65	350	94	0.86	0.00135
66	150	1458	13.39	0.02092
67	250	78	0.72	0.00112
68	250	24	0.22	0.00034
69	250	124	1.14	0.00178
70	250	12	0.11	0.00017
71	250	15	0.14	0.00022
72	250	35	0.32	0.00050
73	150	14784	135.76	0.21212
74	150	567	5.21	0.00814
75	250	1999	18.36	0.02868
76	250	38	0.35	0.00055
77	250	317	2.91	0.00455

Table B-6. Healdsburg Quadrangle Floodplain Data Plane

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
FLOODPLAIN DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
1	ABOV	286819	2633.75	4.11518
2	BELO	184201	1691.45	2.64284
3	ABOV	20	0.18	0.00029
4	ABOV	536960	4930.52	7.70410

Table B-7. Healdsburg Quadrangle Land Use Revision Data Plane

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY REPORT
LAND USE REVISION DATA PLANE

- POLYGON -		-- AREAL COVERAGE --		
NUMBER	LABEL	PIXELS	ACRES	SQ MILES
1		975334	8955.50	13.99371
2	UIS	4390	40.31	0.06299
3	ACC	5606	51.48	0.08043
4	AVV	6200	56.93	0.08896
5	UFS	16470	151.24	0.25631

AD-A144 059 IMAGE-BASED APPROACH TO MAPPING CHARTING AND GEODESY (U) JET PROPULSION LAB PASADENA CA S Z FRIEDMAN FEB 82 JPL-D-1689 ETL-0366 2/2

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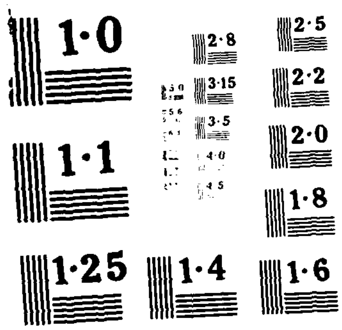

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MICROCOPY RESOLUTION TEST CHART

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (1 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES - LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	-- AREAL COVERAGE -- PIXELS	ACRES	SQ MILES
1	UIS	150	ABOV		109	1.00	0.00156
2	UCR	150	ABOV		209	1.92	0.00300
3	URS	150	ABOV		52030	477.78	0.74652
4	BT	150	ABOV		700	6.43	0.01004
5	UOV	150	ABOV		385	3.54	0.00552
6	UOV	250	ABOV		318	2.92	0.00456
7	URS	250	ABOV		19199	176.30	0.27547
8	URS	350	ABOV		64	0.59	0.00092
9	URS	350	ABOV		13690	125.71	0.19642
10	URS	150	BELO		2154	19.78	0.03091
11	WS	50	BELO		19591	179.90	0.28109
12	FO	50	BELO		1601	14.70	0.02297
13	FO	150	ABOV		8	0.07	0.00011
14	FO	150	ABOV		11	0.10	0.00016
15	FO	150	ABOV		1311	12.04	0.01881
16	FO	250	ABOV		35	0.32	0.00050
17	R	250	ABOV		1992	18.29	0.02858
18	AVV	250	ABOV		401	3.68	0.00575
19	AVV	350	ABOV		8	0.07	0.00011
20	AVV	350	ABOV		124	1.14	0.00178
21	R	250	ABOV		39	0.36	0.00056
22	AVF	250	ABOV		476	4.37	0.00683
23	AVF	150	ABOV		3973	36.48	0.05700
24	WS	150	ABOV		443	4.07	0.00636
25	AVF	150	ABOV		1302	11.96	0.01868
26	URS	50	BELO		13	0.12	0.00019
27	FO	50	ABOV		12	0.11	0.00017
28	FO	150	BELO		271	2.49	0.00389
29	R	350	ABOV		1203	11.05	0.01726
30	AVF	350	ABOV		73	0.67	0.00105
31	R	150	ABOV		616	5.66	0.00884
32	AVV	350	ABOV		366	3.36	0.00525
33	UCC	150	ABOV		2667	24.49	0.03827
34	UCB	150	ABOV		799	7.34	0.01146
35	URS	150	ABOV		13805	126.77	0.19807
36	FO	50	ABOV		112	1.03	0.00161
37	AVV	250	ABOV		71	0.65	0.00102
38	R	250	ABOV		468	4.30	0.00671
39	URS	150	ABOV		113	1.04	0.00162
40	URS	150	ABOV		1180	10.84	0.01693
41	AVV	250	ABOV		53	0.49	0.00076
42	FO	50	BELO		38	0.35	0.00055
43	URS	50	BELO		464	4.26	0.00666

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (2 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IRIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
GEOREF POSITION CODE	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
44	AVV	150	ABOV		162	1.49	0.00232
45	AVF	250	ABOV		313	2.87	0.00449
46	URS	50	BELO		85	0.78	0.00122
47	URS	50	ABOV		84	0.77	0.00121
48	R	150	ABOV		1827	16.78	0.02621
49	URS	350	ABOV		50	0.46	0.00072
50	UOV	150	ABOV		752	6.91	0.01079
51	UOV	250	ABOV		78	0.72	0.00112
52	FO	150	ABOV		9	0.08	0.00013
53	FO	250	ABOV		453	4.21	0.00657
54	FO	150	ABOV		8	0.07	0.00011
55	URS	450	ABOV		74	0.68	0.00106
56	URS	450	ABOV		6270	57.58	0.08996
57	URS	50	BELO		11	0.10	0.00016
58	AVF	250	ABOV		555	5.11	0.00798
59	AVF	150	ABOV		719	6.60	0.01032
60	URS	50	ABOV		29	0.27	0.00042
61	FO	350	ABOV		648	5.95	0.00930
62	UOV	250	ABOV		9	0.08	0.00013
63	URS	50	BELO		8	0.07	0.00011
64	URS	350	ABOV		204	1.87	0.00293
65	AVF	250	ABOV		763	7.05	0.01102
66	URS	50	BELO		299	2.75	0.00429
67	URS	50	BELO		57	0.52	0.00082
68	URS	50	ABOV		115	1.06	0.00165
69	R	450	ABOV		11	0.10	0.00016
70	FO	150	ABOV		18	0.17	0.00026
71	FO	250	ABOV		297	2.73	0.00426
72	FO	450	ABOV		3625	33.29	0.05201
73	URS	450	ABOV		26	0.24	0.00037
74	URS	450	ABOV		21	0.19	0.00030
75	UCR	150	ABOV		317	2.91	0.00455
76	FO	450	ABOV		2466	22.64	0.03538
77	FO	350	ABOV		76	0.70	0.00109
78	URS	450	ABOV		34	0.31	0.00049
79	FO	350	ABOV		1491	13.69	0.02139
80	URS	150	ABOV		150	1.38	0.00215
81	FO	350	ABOV		10	0.09	0.00014
82	URS	450	ABOV		51	0.47	0.00073
83	FO	550	ABOV		3555	32.64	0.05101
84	FO	350	ABOV		11	0.10	0.00016
85	AVF	350	ABOV		166	1.52	0.00238
86	FO	350	ABOV		1210	11.11	0.01736

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (3 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
67	URS	450	ABOV		10	0.09	0.00014
68	FO	350	ABOV		52	0.48	0.00075
69	URS	450	ABOV		39	0.36	0.00056
90	FO	250	ABOV		1431	13.14	0.02053
91	AVF	350	ABOV		334	3.07	0.00479
92	FO	650	ABOV		3528	32.40	0.05062
93	UOG	150	ABOV		4929	45.26	0.07072
94	UOG	250	ABOV		1338	12.29	0.01920
95	FO	550	ABOV		3031	27.83	0.04349
96	URS	550	ABOV		1389	12.75	0.01993
97	FO	750	ABOV		2833	26.01	0.04065
98	URS	550	ABOV		70	0.64	0.00100
99	URS	450	ABOV		56	0.51	0.00080
100	FO	150	ABOV		45	0.41	0.00065
101	FO	350	ABOV		15	0.14	0.00022
102	URS	450	ABOV		14	0.13	0.00020
103	FO	250	ABOV		595	5.46	0.00854
104	URS	450	ABOV		18	0.17	0.00026
105	URS	650	ABOV		797	7.32	0.01144
106	FO	850	ABOV		1864	17.12	0.02674
107	URS	50	BELO		62	0.57	0.00089
108	FO	150	ABOV		25	0.23	0.00036
109	URS	550	ABOV		103	0.95	0.00148
110	FO	150	ABOV		121	1.11	0.00174
111	URS	450	ABOV		224	2.06	0.00321
112	UIS	150	ABOV		82	0.75	0.00118
113	FO	650	ABOV		302	2.77	0.00433
114	FO	950	ABOV		691	6.35	0.00991
115	URS	750	ABOV		62	0.57	0.00089
116	R	50	BELO		35	0.32	0.00050
117	UIS	150	ABOV		1425	13.09	0.02045
118	URS	150	BELO		421	3.87	0.00604
119	R	650	ABOV		553	5.08	0.00793
120	FO	50	BELO		153	1.40	0.00220
121	FO	150	ABOV		377	3.46	0.00541
122	R	550	ABOV		124	1.14	0.00178
123	FO	650	ABOV		1539	14.13	0.02208
124	URS	50	BELO		29	0.27	0.00042
125	UCC	150	ABOV		776	7.13	0.01113
126	URS	450	ABOV		54	0.50	0.00077
127	FO	750	ABOV		362	3.32	0.00519
128	FO	650	ABOV		517	4.75	0.00742
129	URS	150	ABOV		64	0.59	0.00092

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (4 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
130	FO	150	BELO		14	0.13	0.00020
131	URS	50	BELO		132	1.21	0.00189
132	UOC	150	ABOV		1732	15.90	0.02485
133	URS	450	ABOV		121	1.11	0.00174
134	FO	150	BELO		9	0.08	0.00013
135	R	750	ABOV		5107	46.90	0.07328
136	FO	450	ABOV		302	2.77	0.00433
137	URS	50	BELO		425	3.90	0.00610
138	FO	750	ABOV		91	0.84	0.00131
139	FO	450	ABOV		190	1.74	0.00273
140	URS	150	BELO		88	0.81	0.00126
141	R	650	ABOV		1247	11.45	0.01789
142	URS	150	ABOV		996	9.15	0.01429
143	FO	750	ABOV		44	0.40	0.00063
144	UOG	250	ABOV		262	2.41	0.00376
145	UOG	250	ABOV		17	0.16	0.00024
146	FO	450	ABOV		487	4.47	0.00699
147	R	550	ABOV		1063	9.76	0.01525
148	UOG	250	ABOV		329	3.02	0.00472
149	R	150	ABOV		61	0.56	0.00088
150	R	650	ABOV		59	0.54	0.00085
151	UOC	250	ABOV		27	0.25	0.00039
152	R	250	ABOV		216	1.98	0.00310
153	R	450	ABOV		1099	10.09	0.01577
154	URS	50	BELO		27	0.25	0.00039
155	R	350	ABOV		467	4.29	0.00670
156	URS	450	ABOV		48	0.44	0.00069
157	R	650	ABOV		9	0.08	0.00013
158	UCR	150	ABOV		3454	31.72	0.04956
159	FO	350	ABOV		42	0.39	0.00060
160	R	650	ABOV		109	1.00	0.00156
161	URS	250	ABOV		777	7.13	0.01115
162	R	850	ABOV		1277	11.73	0.01832
163	UIS	50	ABOV		334	3.07	0.00479
164	WS	150	BELO		45	0.41	0.00065
165	URS	50	ABOV		93	0.85	0.00133
166	UOG	150	ABOV		36	0.33	0.00052
167	UCC	150	ABOV		404	3.71	0.00580
168	AVV	150	ABOV		413	3.79	0.00593
169	FO	750	ABOV		16	0.15	0.00023
170	AVF	150	ABOV		1984	18.22	0.02847
171	URS	350	ABOV		504	4.63	0.00723
172	AVV	50	ABOV		684	6.28	0.00981

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (5 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240.000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
173	R	350	ABOV		355	3.26	0.00509
174	URS	150	BELO		144	1.32	0.00207
175	UCC	150	ABOV		659	6.05	0.00946
176	URS	150	BELO		16	0.15	0.00023
177	FO	550	ABOV		10213	93.78	0.14654
178	FO	650	ABOV		1140	10.47	0.01636
179	UCC	150	ABOV		784	7.20	0.01125
180	URS	50	BELO		251	2.30	0.00360
181	URS	150	BELO		26	0.24	0.00037
182	FO	450	ABOV		8	0.07	0.00011
183	R	850	ABOV		1866	17.13	0.02677
184	UCR	50	ABOV		4282	39.32	0.06144
185	FO	450	ABOV		5122	47.03	0.07349
186	FO	50	BELO		263	2.42	0.00377
187	URS	50	BELO		66	0.61	0.00095
188	URS	150	BELO		12	0.11	0.00017
189	FO	150	BELO		169	1.55	0.00242
190	URS	150	BELO		99	0.91	0.00142
191	URS	50	BELO		20	0.18	0.00029
192	FO	250	ABOV		4128	37.91	0.05923
193	UCW	50	ABOV		551	5.06	0.00791
194	FO	350	ABOV		3611	33.16	0.05181
195	FO	750	ABOV		281	2.58	0.00403
196	UCO	50	ABOV		1688	15.50	0.02422
197	FO	150	ABOV		3163	29.09	0.04545
198	URS	50	BELO		33	0.30	0.00047
199	FO	50	BELO		83	0.76	0.00119
200	R	50	BELO		223	2.05	0.00320
201	AVF	150	BELO		229	2.10	0.00329
202	URS	150	BELO		81	0.74	0.00116
203	URS	50	BELO		35	0.32	0.00050
204	FO	150	BELO		353	3.24	0.00506
205	FO	50	BELO		8	0.07	0.00011
206	R	150	BELO		137	1.26	0.00197
207	AVF	50	BELO		12	0.11	0.00017
208	AVF	150	ABOV		2354	21.62	0.03378
209	AVV	150	ABOV		240	2.20	0.00344
210	URS	50	BELO		13	0.12	0.00019
211	AVF	50	BELO		1945	17.87	0.02792
212	R	150	ABOV		1284	11.79	0.01842
213	AVF	50	ABOV		99	0.91	0.00142
214	BT	150	ABOV		873	8.02	0.01253
215	AVF	150	ABOV		16	0.15	0.00023

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES - LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	-- AREAL COVERAGE -- PIXELS	ACRES	SQ MILES
216	AVF	50	BELO		270	2.48	0.00387
217	R	150	BELO		50	0.46	0.00072
218	AVV	50	BELO		795	7.30	0.01141
219	WS	150	BELO		47	0.43	0.00067
220	AVV	50	ABOV		15	0.14	0.00022
221	FO	750	ABOV		1367	12.55	0.01961
222	AVF	150	BELO		581	5.34	0.00834
223	R	950	ABOV		209	1.92	0.00300
224	UCW	50	ABOV		260	2.39	0.00373
225	WS	150	BELO		6	0.06	0.00009
226	R	250	ABOV		2206	20.26	0.03165
227	AVF	150	ABOV		901	8.27	0.01293
228	AVV	150	BELO		11	0.10	0.00016
229	UOP	150	ABOV		171	1.57	0.00245
230	UCB	150	ABOV		594	5.45	0.00852
231	URS	50	ABOV		1496	13.74	0.02146
232	FO	850	ABOV		136	1.25	0.00195
233	URS	50	BELO		156	1.43	0.00224
234	R	650	ABOV		151	1.39	0.00217
235	R	750	ABOV		164	1.51	0.00235
236	FO	850	ABOV		1217	11.18	0.01746
237	AVF	50	BELO		1796	16.49	0.02577
238	FO	350	ABOV		43	0.39	0.00062
239	URS	50	BELO		2199	20.19	0.03155
240	R	850	ABOV		256	2.35	0.00367
241	UUT	50	ABOV		3572	32.80	0.05125
242	URS	150	BELO		534	4.90	0.00766
243	R	550	ABOV		101	0.93	0.00145
244	URS	150	BELO		20	0.18	0.00029
245	URS	150	BELO		437	4.01	0.00627
246	R	250	ABOV		107	0.98	0.00154
247	R	250	ABOV		139	1.28	0.00199
248	URS	50	BELO		67	0.62	0.00096
249	URS	50	ABOV		9	0.08	0.00013
250	R	350	ABOV		2125	19.52	0.03050
251	R	750	ABOV		703	6.46	0.01009
252	AVV	150	ABOV		489	4.49	0.00702
253	FO	750	ABOV		347	3.19	0.00498
254	R	850	ABOV		12	0.11	0.00017
255	FO	650	ABOV		7179	65.92	0.10300
256	URS	150	BELO		13	0.12	0.00019
257	AVV	150	BELO		29	0.27	0.00042
258	FO	950	ABOV		1656	15.21	0.02376

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (7 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
GEOREF REGION CODE	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
259	R	850	ABOV		172	1.58	0.00247
260	FO	850	ABOV		61	0.56	0.00088
261	BT	150	BELO		239	2.19	0.00343
262	AVV	150	BELO		208	1.91	0.00298
263	URS	50	ABOV		921	8.46	0.01321
264	AR	150	ABOV		887	8.15	0.01273
265	FO	750	ABOV		337	3.09	0.00464
266	FO	350	ABOV		2439	22.40	0.03499
267	AVF	50	ABOV		811	7.45	0.01164
268	AVF	150	BELO		167	1.53	0.00240
269	UCR	150	ABOV		615	5.65	0.00882
270	BT	50	BELO		449	4.12	0.00644
271	AVF	150	BELO		48	0.44	0.00069
272	FO	1050	ABOV		340	3.12	0.00488
273	AVF	50	BELO		926	8.50	0.01329
274	R	750	ABOV		980	9.00	0.01406
275	AVV	50	BELO		423	3.93	0.00614
276	FO	150	ABOV		649	5.96	0.00931
277	AVF	150	BELO		199	1.83	0.00286
278	R	450	ABOV		814	7.47	0.01168
279	URS	50	BELO		10	0.09	0.00014
280	UCW	50	ABOV		1065	9.79	0.01529
281	R	150	ABOV		2376	21.82	0.03409
282	LR	50	BELO		437	4.01	0.00627
283	AR	250	ABOV		386	3.54	0.00554
284	FO	450	ABOV		1489	13.67	0.02136
285	FO	250	ABOV		1531	14.06	0.02197
286	LR	150	ABOV		215	1.97	0.00308
287	FO	750	ABOV		85	0.78	0.00122
288	R	850	ABOV		1333	12.24	0.01913
289	R	950	ABOV		283	2.60	0.00406
290	R	250	ABOV		994	9.13	0.01426
291	R	1050	ABOV		35	0.32	0.00050
292	UUT	50	ABOV		47	0.43	0.00067
293	FO	850	ABOV		20	0.18	0.00029
294	UUT	150	ABOV		954	8.76	0.01369
295	AVF	150	ABOV		5362	49.24	0.07693
296	R	650	ABOV		30	0.28	0.00043
297	UIL	50	ABOV		1160	10.65	0.01664
298	UIL	150	ABOV		305	2.80	0.00438
299	UES	50	BELU		3832	35.19	0.05498
300	URS	50	BELO		584	5.36	0.00838
301	R	550	ABOV		34	0.31	0.00049

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (8 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IRIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
302	URS	50	BELO		757	6.95	0.01086
303	URS	50	ABOV		21	0.19	0.00030
304	FO	750	ABOV		197	1.81	0.00283
305	R	550	ABOV		19	0.17	0.00027
306	URS	50	ABOV		13	0.12	0.00019
307	LR	50	BELO		8	0.07	0.00011
308	R	550	ABOV		49	0.45	0.00070
309	URS	150	BELO		82	0.75	0.00118
310	AVF	50	ABOV		5175	47.53	0.07427
311	URS	150	ABOV		1671	15.34	0.02398
312	R	350	ABOV		979	8.99	0.01405
313	FO	850	ABOV		42	0.39	0.00060
314	UES	150	BELO		46	0.42	0.00066
315	UES	150	ABOV		903	8.29	0.01296
316	URS	50	ABOV		2087	19.16	0.02994
317	AVF	150	BELO		108	0.99	0.00155
318	ACC	50	ABOV		1222	11.22	0.01753
319	UES	50	ABOV		707	6.49	0.01014
320	UES	150	BELO		12	0.11	0.00017
321	URS	150	ABOV		64	0.59	0.00092
322	R	950	ABOV		137	1.26	0.00197
323	UES	50	ABOV		18	0.17	0.00026
324	URS	150	ABOV		11	0.10	0.00016
325	R	450	ABOV		1052	9.66	0.01509
326	URS	50	ABOV		2081	19.11	0.02986
327	URS	150	BELO		24	0.22	0.00034
328	FO	750	ABOV		1811	16.63	0.02598
329	UUT	50	ABOV		65	0.60	0.00093
330	FO	850	ABOV		1324	12.16	0.01900
331	URS	150	ABOV		61	0.56	0.00088
332	UES	150	BELO		11	0.10	0.00016
333	URS	150	BELO		38	0.35	0.00055
334	UES	150	BELO		71	0.65	0.00102
335	UES	150	BELO		13	0.12	0.00019
336	AVF	50	ABOV	UIS	1918	17.61	0.02752
337	R	550	ABOV		15	0.14	0.00022
338	FO	550	ABOV		9	0.08	0.00013
339	R	550	ABOV		46	0.42	0.00066
340	ACP	650	ABOV		6963	63.94	0.09990
341	R	650	ABOV		17	0.16	0.00024
342	UES	150	BELO		21	0.19	0.00030
343	URS	150	ABOV		26	0.24	0.00037
344	URS	50	BELO		155	1.42	0.00222

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240.000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES - LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	-- AREAL COVERAGE -- PIXELS	ACRES	SQ MILES
345	R	550	ABOV		47	0.43	0.00067
346	ACP	550	ABOV		5403	49.61	0.07752
347	FO	650	ABOV		28	0.26	0.00040
348	FO	750	ABOV		1067	9.80	0.01531
349	UES	150	BELO		21	0.19	0.00030
350	ACP	450	ABOV		3915	35.95	0.05617
351	R	950	ABOV		2574	23.64	0.03693
352	UES	150	BELO		169	1.55	0.00242
353	UES	50	ABOV		191	1.75	0.00274
354	ACP	750	ABOV		3196	29.35	0.04586
355	URS	150	ABOV		43	0.44	0.00069
356	ACP	350	ABOV		3737	34.32	0.05362
357	AVF	50	ABOV		19796	181.78	0.28403
358	URS	150	BELO		35	0.32	0.00050
359	UOP	150	BELO		223	2.09	0.00327
360	UOP	50	BELO		869	7.98	0.01247
361	ACP	250	ABOV		1971	18.10	0.02828
362	URS	50	BELO		46	0.42	0.00066
363	UOC	50	ABOV		864	7.93	0.01240
364	UCR	50	ABOV		621	5.70	0.00891
365	UIS	50	ABOV		502	4.61	0.00720
366	UES	50	BELO		11	0.10	0.00016
367	ACP	150	ABOV		6924	63.58	0.09935
368	AVF	150	ABOV		166	1.52	0.00238
369	AVV	50	ABOV		1460	13.41	0.02095
370	UIS	50	BELO		686	6.30	0.00984
371	AVV	50	ABOV	UIS	526	4.83	0.00755
372	URH	50	ABOV		700	6.43	0.01004
373	URH	50	BELO		121	1.11	0.00174
374	UOP	150	BELO		27	0.25	0.00039
375	UIS	50	ABOV		35	0.32	0.00050
376	AVV	50	ABOV		703	6.46	0.01009
377	R	650	ABOV		496	4.55	0.00712
378	UIS	150	BELO		26	0.24	0.00037
379	UIS	50	ABOV	UIS	1006	9.24	0.01443
380	R	750	ABOV		4513	41.44	0.06475
381	R	850	ABOV		57	0.52	0.00082
382	UES	50	BELO		781	7.17	0.01121
383	R	850	ABOV		2184	20.06	0.03134
384	ACC	50	ABOV	UIS	940	8.63	0.01349
385	AVF	50	ABOV		14330	131.59	0.20561
386	FO	950	ABOV		20	0.18	0.00029
387	URS	50	ABOV		1923	17.66	0.02759

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
388	URS	50	BELO		505	4.64	0.00725
389	BES	150	BELO		194	1.78	0.00278
390	UIS	150	BELO		37	0.34	0.00053
391	AVV	50	ABOV		704	6.46	0.01010
392	FO	950	ABOV		99	0.91	0.00142
393	AVV	150	ABOV		665	6.11	0.00954
394	AVV	50	ABOV		1390	12.76	0.01994
395	URS	50	BELO		297	2.73	0.00426
396	URS	50	ABOV		49	0.45	0.00070
397	R	650	ABOV		6414	58.90	0.09203
398	URS	150	BELO		27	0.25	0.00039
399	UIW	250	ABOV		126	1.16	0.00181
400	UIW	150	ABOV		222	2.04	0.00319
401	VV	50	BELO		658	6.04	0.00944
402	VV	150	BELO		21	0.19	0.00030
403	AVV	250	ABOV		1186	10.89	0.01702
404	LR	50	BELO		333	3.06	0.00478
405	AVF	50	BELO		1228	11.28	0.01762
406	AVV	150	ABOV		583	5.35	0.00836
407	AVV	350	ABOV		301	2.76	0.00432
408	ACC	50	ABOV		197	1.81	0.00283
409	UUT	50	BELO		201	1.85	0.00288
410	ACC	50	ABOV	ACC	1188	10.91	0.01705
411	AVV	50	ABOV	ACC	4309	39.57	0.06183
412	ACP	50	ABOV		3794	34.84	0.05444
413	ACP	250	ABOV		301	2.76	0.00432
414	AVF	50	BELO		211	1.94	0.00303
415	ACP	250	ABOV		184	1.69	0.00264
416	R	750	ABOV		9	0.08	0.00013
417	ACP	550	ABOV		31	0.28	0.00044
418	R	550	ABOV		8639	79.33	0.12395
419	UIL	50	ABOV		1112	10.21	0.01595
420	ACC	50	ABOV		2144	19.69	0.03076
421	WS	50	ABOV		55	0.51	0.00079
422	WS	50	ABOV	ACC	13	0.12	0.00019
423	WS	50	BELO	ACC	38	0.35	0.00055
424	LR	50	BELO		261	2.40	0.00374
425	AVV	250	ABOV		9	0.08	0.00013
426	R	650	ABOV		954	8.76	0.01369
427	AVF	50	ABOV		5099	46.82	0.07316
428	R	450	ABOV		6206	56.99	0.08904
429	WS	50	BELO		284	2.61	0.00407
430	R	150	ABOV		7439	68.31	0.10673

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (11 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
431	R	250	ABOV		7887	72.42	0.[illegible]16
432	F	350	ABOV		6004	55.13	0[illegible]15
433	AVF	50	ABOV	ACC	22	0.20	0[illegible]032
434	URS	50	BELO		74	0.68	0[illegible]106
435	F	250	ABOV		193	1.77	0[illegible]277
436	UUT	50	BELO		1290	11.85	[illegible]1851
437	R	150	ABOV		58	0.53	[illegible]93
438	AVF	50	BELO		232	2.13	0[illegible]33
439	UCO	50	ABOV		89	0.82	0.[illegible]128
440	UCO	50	BELO		486	4.46	0.00697
441	URS	50	ABOV		1394	12.80	0.02000
442	LR	50	BELO		3899	35.80	0.05594
443	ACP	250	ABOV		672	6.17	0.00964
444	ACC	50	ABOV		3687	33.86	0.05290
445	AR	650	ABOV		840	7.71	0.01205
446	AVF	50	BELO		3526	32.38	0.05059
447	LR	50	ABOV		917	8.42	0.01316
448	ACC	50	ABOV		2190	20.11	0.03142
449	UUT	50	ABOV		674	6.19	0.00967
450	AVV	50	BELO	ACC	25	0.23	0.00036
451	AVF	50	ABOV	AVV	1810	16.62	0.02597
452	R	650	ABOV		197	1.81	0.00283
453	LR	50	BELO		15	0.14	0.00022
454	WS	50	BELO	ACC	11	0.10	0.00016
455	AVF	50	BELO		83	0.76	0.00119
456	WS	50	BELO		416	3.82	0.00597
457	AVF	50	BELO	AVV	88	0.81	0.00126
458	LR	50	BELO		72	0.66	0.00103
459	AVV	50	ABOV	AVV	1931	17.73	0.02771
460	AVF	50	ABOV		415	3.81	0.00595
461	R	450	ABOV		2559	23.50	0.03672
462	AVF	50	ABOV		4229	38.83	0.06068
463	UUT	150	ABOV		3009	27.63	0.04317
464	AVF	150	ABOV		1766	16.22	0.02534
465	R	250	ABOV		517	4.75	0.00742
466	AVF	50	BELO		51	0.47	0.00073
467	ACP	50	ABOV	AVV	1001	9.19	0.01436
468	AVF	50	ABOV	AVV	955	8.77	0.01370
469	AVF	50	BELO		273	2.51	0.00392
470	R	550	ABOV		169	1.55	0.00242
471	ACC	150	ABOV		1689	15.51	0.02423
472	AVF	50	BELO	AVV	9	0.08	0.00013
473	AVF	50	BELO	AVV	164	1.51	0.00235

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (12 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IRIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
474	AVF	50	ABOV		43	0.39	0.00062
475	AVV	50	BELO		576	5.29	0.00826
476	AVV	50	BELO	AVV	117	1.07	0.00168
477	AVV	50	ABOV		350	3.21	0.00502
478	LR	50	BELO		31	0.28	0.00044
479	AVF	50	ABOV		9	0.08	0.00013
480	AVF	50	BELO		9	0.08	0.00013
481	ACP	50	BELO	AVV	28	0.26	0.00040
482	LR	50	ABOV		88	0.81	0.00126
483	AVF	50	BELO		9	0.08	0.00013
484	AVV	150	ABOV		7366	67.64	0.10569
485	AVV	50	ABOV		8384	76.99	0.12029
486	AVF	50	ABOV		1820	16.71	0.02611
487	LR	150	ABOV		59	0.54	0.00085
488	AVF	50	BELO		2201	20.21	0.03158
489	URS	50	BELO		790	7.25	0.01133
490	ACP	50	BELO	AVV	97	0.89	0.00139
491	ACP	250	ABOV		24711	226.91	0.35455
492	URS	50	ABOV		410	3.76	0.00588
493	AVV	150	ABOV		1282	11.77	0.01839
494	AVF	150	ABOV	URS	4059	37.27	0.05824
495	AVV	150	ABOV	URS	503	4.62	0.00722
496	AVV	250	ABOV	URS	451	4.14	0.00647
497	ACP	250	ABOV	URS	1683	15.45	0.02415
498	ACP	350	ABOV		9204	84.52	0.13206
499	ACP	450	ABOV		2958	27.16	0.04244
500	ACP	550	ABOV		83	0.76	0.00119
501	AVV	150	ABOV		3576	32.84	0.05131
502	UIW	150	ABOV		829	7.61	0.01189
503	AVF	150	ABOV		1965	18.04	0.02819
504	AVV	150	ABOV		10647	97.77	0.15276
505	ACC	150	ABOV		1347	12.37	0.01933
506	LR	50	BELO		15	0.14	0.00022
507	AVV	50	BELO		3673	33.73	0.05270
508	AVV	50	ABOV		206	1.89	0.00296
509	AVF	50	BELO		10	0.09	0.00014
510	AVF	250	ABOV	URS	36	0.33	0.00052
511	R	350	ABOV		1721	15.80	0.02469
512	WWP	450	ABOV		25	0.23	0.00036
513	AVV	50	ABOV		5058	46.45	0.07257
514	AVF	50	BELO		235	2.16	0.00337
515	AVV	250	ABOV		462	4.24	0.00663
516	AVF	250	ABOV	URS	213	1.96	0.00306

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
517	ACP	150	ABOV	URS	29	0.27	0.00042
518	AVV	150	ABOV	URS	848	7.79	0.01217
519	AVV	250	ABOV	URS	79	0.73	0.00113
520	WS	50	BELO		830	7.62	0.01191
521	AVF	150	ABOV		180	1.65	0.00258
522	AVV	50	BELO		231	2.12	0.00331
523	AVV	50	ABOV		28	0.26	0.00040
524	R	450	ABOV		253	2.32	0.00363
525	BT	450	ABOV		140	1.29	0.00201
526	AVF	50	BELO		1824	16.75	0.02617
527	BT	350	ABOV		756	6.94	0.01085
528	LR	50	BELO		487	4.47	0.00699
529	ACC	50	ABOV		134	1.23	0.00192
530	ACC	150	ABOV		84	0.77	0.00121
531	AVV	150	ABOV	URS	2100	19.28	0.03013
532	ACP	550	ABOV		28	0.26	0.00040
533	R	350	ABOV		761	6.99	0.01092
534	AVF	50	ABOV		3366	30.91	0.04830
535	AVV	250	ABOV	URS	1155	10.61	0.01657
536	AVV	50	BELO		390	3.58	0.00560
537	URS	150	ABOV		708	6.50	0.01016
538	ACP	150	ABOV	URS	1777	16.32	0.02550
539	ACP	150	ABOV	URS	21	0.19	0.00030
540	ACP	250	ABOV	URS	1321	12.13	0.01895
541	AVV	250	ABOV	URS	133	1.22	0.00191
542	AVV	50	BELO		578	5.31	0.00829
543	URS	150	ABOV	URS	1687	15.49	0.02421
544	F	450	ABOV		13	0.12	0.00019
545	BT	250	ABOV		6238	57.28	0.08950
546	AVV	50	ABOV		237	2.18	0.00340
547	R	250	ABOV		49	0.45	0.00070
548	AVF	50	BELO		4574	42.00	0.06563
549	BT	350	ABOV		50	0.46	0.00072
550	BBR	50	BELO		183	1.68	0.00263
551	AVV	50	ABOV		500	4.59	0.00717
552	WWP	250	ABOV		270	2.48	0.00387
553	ACP	450	ABOV		428	3.93	0.00614
554	R	250	ABOV		105	0.96	0.00151
555	AVF	50	ABOV		1397	12.83	0.02004
556	AVV	150	ABOV	URS	51	0.47	0.00073
557	AVV	50	BELO		918	8.43	0.01317
558	ACP	250	ABOV		36	0.33	0.00052
559	AVV	150	ABOV		63	0.58	0.00090

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (14 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
560	AVV	50	BELO		11	0.10	0.00016
561	UES	50	BELO		4089	37.55	0.05867
562	ACP	250	ABOV	URS	324	2.98	0.00465
563	UES	50	ABOV		102	0.94	0.00146
564	R	250	ABOV		879	8.07	0.01261
565	R	350	ABOV		1593	14.63	0.02286
566	AVF	50	ABOV		273	2.51	0.00392
567	ST	350	ABOV		29	0.27	0.00042
568	AVV	150	ABOV		185	1.70	0.00265
569	ACP	150	ABOV		37198	341.58	0.53372
570	AVV	50	BELO		47323	434.55	0.67899
571	R	450	ABOV		568	5.22	0.00815
572	AVV	50	ABOV		52	0.48	0.00075
573	AVF	50	ABOV		291	2.67	0.00418
574	ACP	150	ABOV		2124	19.50	0.03048
575	ACC	50	ABOV		720	6.61	0.01033
576	ACC	150	ABOV		91	0.84	0.00131
577	ACC	50	ABOV		100	0.92	0.00143
578	ACC	50	BELO		6112	56.12	0.08769
579	AVF	150	ABOV		40	0.37	0.00057
580	URS	50	ABOV		337	3.09	0.00484
581	AVV	50	ABOV		8387	77.02	0.12034
582	AR	150	ABOV		425	3.90	0.00610
583	BBR	50	BELO		473	4.34	0.00679
584	URH	150	ABOV		283	2.60	0.00406
585	AVV	150	ABOV		49	0.45	0.00070
586	AVV	50	ABOV		12078	110.91	0.17329
587	UUS	50	BELO		1537	14.11	0.02205
588	AVF	50	BELO		400	3.67	0.00574
589	AVF	50	ABOV		878	8.06	0.01260
590	AVF	50	BELO		52	0.48	0.00075
591	AR	50	ABOV		381	3.50	0.00547
592	ACP	350	ABOV		33	0.30	0.00047
593	URS	150	ABOV		402	3.69	0.00577
594	R	550	ABOV		12	0.11	0.00017
595	UIS	150	ABOV		464	4.26	0.00666
596	ACC	50	ABOV		248	2.28	0.00356
597	UIS	50	ABOV		1148	10.54	0.01647
598	WO	50	BELO		3269	30.02	0.04690
599	AVF	50	BELO		459	4.21	0.00659
600	AVV	50	ABOV		202	1.85	0.00290
601	AVV	50	BELO		11713	107.56	0.16806
602	URS	50	ABOV		358	3.29	0.00514

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (15 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES - LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	-- AREAL COVERAGE -- PIXELS	ACRES	SQ MILES
603	ACP	50	ABOV		63	0.58	0.00090
604	ACC	150	ABOV		3173	29.18	0.04560
605	R	250	ABOV		33	0.30	0.00047
606	R	250	ABOV		16	0.15	0.00023
607	UIS	50	ABOV		13	0.12	0.00019
608	AVV	150	ABOV		15	0.14	0.00022
609	R	250	ABOV		37	0.34	0.00053
610	AR	50	ABOV		2164	19.87	0.03105
611	AR	150	ABOV		139	1.28	0.00199
612	ACC	50	ABOV		149	1.37	0.00214
613	AVV	50	BELO		108	0.99	0.00155
614	URS	150	ABOV		400	3.67	0.00574
615	BT	350	ABOV		94	0.86	0.00135
616	AVF	50	ABOV		276	2.53	0.00396
617	AVF	50	BELO		3931	36.10	0.05640
618	ACC	50	ABOV		14	0.13	0.00020
619	AR	150	ABOV		378	3.47	0.00542
620	ACP	50	ABOV		2050	18.82	0.02941
621	ACP	150	ABOV		82	0.75	0.00118
622	AVV	150	ABOV		1804	16.57	0.02588
623	ACP	50	ABOV		555	5.10	0.00796
624	AVV	150	ABOV		286	2.63	0.00410
625	ACP	250	ABOV		5192	47.68	0.07449
626	ACP	150	ABOV		3306	30.36	0.04743
627	URS	150	ABOV		6862	63.01	0.09846
628	URS	150	ABOV		471	4.33	0.00676
629	URS	150	ABOV		1141	10.48	0.01637
630	AVV	50	ABOV		49	0.45	0.00070
631	URS	50	ABOV		267	2.45	0.00383
632	ACP	250	ABOV		340	3.12	0.00488
633	URS	50	ABOV		222	2.04	0.00319
634	UUT	250	ABOV		55	0.51	0.00079
635	AVV	150	ABOV		114	1.05	0.00164
636	AVV	250	ABOV		576	5.29	0.00826
637	URS	250	ABOV		23	0.21	0.00033
638	ACP	250	ABOV		24	0.22	0.00034
639	AVF	150	ABOV		44	0.40	0.00063
640	AVF	50	ABOV		480	4.41	0.00689
641	UUT	150	ABOV		2492	22.88	0.03576
642	AVF	250	ABOV		210	1.93	0.00301
643	ACP	50	BELO		750	6.89	0.01076
644	ACP	250	ABOV		124	1.14	0.00178
645	WWP	250	ABOV		172	1.58	0.00247

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (16 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240,000   1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
646	URS	250	ABOV		12	0.11	0.00017
647	ACP	50	ABOV		102	0.94	0.00146
648	AVV	150	ABOV		45	0.41	0.00065
649	URS	250	ABOV		15	0.14	0.00022
650	URS	50	ABOV		101	0.93	0.00145
651	URS	250	ABOV		35	0.32	0.00050
652	FO	50	ABOV		135	1.24	0.00194
653	URS	150	ABOV		175	1.61	0.00251
654	ACP	250	ABOV		2251	20.67	0.03230
655	AVF	250	ABOV		243	2.23	0.00349
656	BT	150	ABOV		12	0.11	0.00017
657	AVV	150	ABOV		71	0.65	0.00102
658	WWP	250	ABOV		73	0.67	0.00105
659	R	250	ABOV		164	1.51	0.00235
660	UUS	50	ABOV		67	0.62	0.00096
661	WWP	150	ABOV		304	2.79	0.00436
662	UUS	50	BELO		24	0.22	0.00034
663	ACC	50	BELO		232	2.13	0.00333
664	ACP	150	ABOV		11	0.10	0.00016
665	ACC	50	ABOV		447	4.10	0.00641
666	ACC	150	ABOV		1733	15.91	0.02487
667	WWP	150	ABOV		321	2.95	0.00461
668	ACP	150	ABOV		91	0.84	0.00131
669	ACP	250	ABOV		52	0.48	0.00075
670	AVF	50	BELO		4593	42.18	0.06590
671	UCC	50	ABOV		962	8.83	0.01380
672	ACC	150	ABOV		144	1.32	0.00207
673	ACC	50	BELO		86	0.79	0.00123
674	R	250	ABOV		54	0.50	0.00077
675	ACP	150	ABOV		13	0.12	0.00019
676	ACC	150	ABOV		2953	27.12	0.04237
677	URS	50	ABOV		613	5.63	0.00880
678	AVF	50	ABOV		627	5.76	0.00900
679	URS	50	ABOV		16	0.15	0.00023
680	BT	250	ABOV		771	7.08	0.01106
681	ACP	50	ABOV		177	1.63	0.00254
682	AVF	50	ABOV		16	0.15	0.00023
683	AVF	150	ABOV		2895	26.58	0.04154
684	BT	150	ABOV		2284	20.97	0.03277
685	URS	150	ABOV		49	0.45	0.00070
686	AVF	50	ABOV		9	0.08	0.00013
687	AVV	50	BELO		942	8.65	0.01352
688	AVV	50	ABOV		2857	26.23	0.04099

Table B-8. Healdsburg Quadrangle Summary of Georeference Base (17 of 18)

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240.000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY. ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES - LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	-- AREAL COVERAGE -- PIXELS	ACRES	SQ MILES
689	ACP	150	ABOV		1228	11.28	0.01762
690	URS	150	ABOV		103	0.95	0.00148
691	AVV	150	ABOV		399	3.66	0.00572
692	AVV	50	ABOV		652	5.99	0.00935
693	UCC	150	ABOV		65	0.60	0.00093
694	URS	50	ABOV		183	1.68	0.00263
695	URS	150	ABOV		29	0.27	0.00042
696	AVF	50	BELO		1371	12.59	0.01967
697	AVV	150	ABOV		80	0.73	0.00115
698	AVV	50	ABOV		1579	14.50	0.02266
699	ACC	150	ABOV		1308	12.01	0.01877
700	AVV	150	ABOV		419	3.85	0.00601
701	URS	150	ABOV		82	0.75	0.00118
702	AVV	150	ABOV		2456	22.55	0.03524
703	BBR	50	BELO		2295	21.07	0.03293
704	AVV	150	ABOV		1967	18.06	0.02822
705	AVF	50	ABOV		1710	15.70	0.02454
706	ACP	150	ABOV		2974	27.31	0.04267
707	AVF	150	ABOV		855	7.85	0.01227
708	AVV	150	ABOV		1721	15.80	0.02469
709	ACP	150	ABOV		6018	55.26	0.08635
710	URS	50	ABOV		448	4.11	0.00643
711	AVF	150	ABOV		6268	57.56	0.08993
712	ACC	50	BELO		2849	26.16	0.04088
713	URS	150	ABOV		1147	10.53	0.01646
714	AVV	50	ABOV		241	2.21	0.00346
715	ACC	50	ABOV		1344	12.34	0.01928
716	URS	50	BELO		249	2.29	0.00357
717	ACC	150	ABOV		1357	12.46	0.01947
718	URS	50	ABOV		317	2.91	0.00455
719	URS	50	ABOV		371	3.41	0.00532
720	URS	150	ABOV		2869	26.35	0.04116
721	AVV	150	ABOV		15	0.14	0.00022
722	URS	150	ABOV		538	5.40	0.00844
723	AVV	150	ABOV		1468	13.48	0.02106
724	AVF	150	ABOV		613	5.67	0.00887
725	AVV	150	ABOV		39	0.36	0.00056
726	AVV	250	ABOV		1544	14.18	0.02215
727	AVV	250	ABOV		38	0.35	0.00055
728	ACP	150	ABOV		8199	75.29	0.11764
729	URS	150	ABOV		5207	47.81	0.07471
730	ACP	150	ABOV		3363	30.88	0.04825
731	AVV	150	ABOV		509	4.67	0.00730

HEALDSBURG QUADRANGLE: NW QUARTER SECTION
EFFECTIVE PIXEL SCALE: 1:240.000 1 PIXEL = 400 SQ FT

IBIS TEST DATA BASE FOR
US ARMY, ENGINEER TOPOGRAPHIC LABORATORIES

SUMMARY OF GEOREFERENCE BASE

GEOREF REGION CODE	- DATA PLANE ATTRIBUTES -				-- AREAL COVERAGE --		
	LAND USE	MEAN ELEV	FLOOD PLAIN	L USE CHANGE	PIXELS	ACRES	SQ MILES
732	AVV	50	ABOV		324	2.98	0.00465
733	LF	50	BELO		827	7.59	0.01187
734	AVV	150	ABOV		676	6.21	0.00970
735	AVV	50	BELO		1626	14.93	0.02333
736	AVV	50	ABOV		1637	15.03	0.02349
737	AVV	50	ABOV		684	6.28	0.00981
738	AVV	150	ABOV		3163	29.04	0.04538
739	AVV	150	ABOV		230	2.11	0.00330
740	ACP	150	ABOV		1955	17.95	0.02805
741	ACP	250	ABOV		455	4.18	0.00653
742	UIS	150	ABOV		472	4.33	0.00677
743	ACP	50	ABOV		797	7.32	0.01144
744	ACP	250	ABOV		317	2.91	0.00455
745	ACC	150	ABOV		1143	10.50	0.01640
746	BEQ	50	BELO		1441	13.23	0.02068
747	AR	50	ABOV		991	9.10	0.01422
748	WO	50	BELO		798	7.33	0.01145
749	ACP	150	ABOV		782	7.18	0.01122
750	BT	150	ABOV		671	6.16	0.00963
751	AVV	150	ABOV		888	8.15	0.01274
752	AVF	150	ABOV		2603	23.90	0.03735
753	AVF	50	BELO		3802	34.91	0.05455
754	AVV	150	ABOV		2025	18.59	0.02905
755	WWP	150	ABOV		54	0.50	0.00077
756	AVF	50	ABOV		377	3.46	0.00541
757	AR	150	ABOV		265	2.43	0.00380
758	AVV	150	ABOV		454	4.17	0.00651
759	URS	150	ABOV		1501	13.78	0.02154
760	AVV	150	ABOV		278	2.55	0.00399
761	URS	150	ABOV		256	2.35	0.00367
762	AVV	50	BELO		869	7.98	0.01247
763	AVV	150	ABOV		359	3.30	0.00515
764	AVV	50	ABOV		82	0.75	0.00118
					1008000	9255.39	14.46238

END

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